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FOREIGN AGRICULTURE REPORT

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FOREIGN AGRICULTURAL RELATIONS
U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

A STUDY OF THE CITRUS INDUSTRY OF ITALY

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by

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F O R E W O R D

This report presents the results of a survey of the citrus industry in Italy, made in the interests of the United States citrus industry. The purpose of the study was to obtain information on production, consumption, and trade as a basis for an evaluation of the probable effect of changing conditions in the Italian industry on international citrus markets. For the past 40 years Italy has been an important factor in world citrus markets, and its production of lemons is second only to that of the United States.

This study was made by the Office of Foreign Agricultural Relations under the provisions of the Research and Marketing Act. The possibilities of broadening and maintaining foreign markets for other agricultural commodities are also being studied by this Office, and the findings are presented in circulars and reports published by the Office of Foreign Agricultural Relations, United States Department of Agriculture, Washington 25, D. C.

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A C K N O W L E D G M E N T

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CONTENTS

Introduction 1
Summary 5
Citrus Production 8
Citrus Acreage 10
  Lemon Acreage 10
  Orange Acreage 11
  Tangerine Acreage 11
Citrus Districts 15
  Sicily 15
  Italian Peninsula 17
Climate 19
  Rainfall 19
  Temperature 20
  Frost 20
Cultural Practices 22
  Labor 22
  Mixed Culture 23
  Planting Distance 24
  Pruning 25
  Nursery Trees and Root Stock 25
  Irrigation 26
  Fertilization 28
  Verdelli Practice 29
  Pest Control 33
  Disease Control 35
  Experiment Station at Acireale 38
Italian Citrus Varieties 39
  Orange Varieties 39
  Lemon Varieties 40
  Descriptions of Lemon and Orange Varieties 41
  Further Identification of Italian Orange Varieties 51
  Other Citrus 56
Cost of Production 58
  Some Production Cost Factors 59
  Examples of Production Cost 59
  Computed Cost of Hypothetical Grove 64
  Computation of a Range of Break-even Costs 66
Marketing of Italian Lemons 69
  Selling 69
  Picking 69
  Packing 70
  Packing Counts and Grade Indications 70
  Packing Costs 72

Marketing of Italian Lemons (continued)
Domestic Marketing 74
Domestic Consumption 74
Transportation 76
Orchard Price of Italian Lemons 78
Export Marketing 80
Seasonal Factors in the Export of Italian Citrus 85
Changes in Italian Export Customers 86
Trade Agreements 88
United States Imports of Italian Lemons 93
Processing 95
Processing Plants 95
Processing Practices 99
Definitions of Processed Citrus for the European Market .101
Essential Oils 101
Citric Acid 103
Citric Juices 104
Comparison of Italian and United States Juices 104
Pectin 109
Nonfruit Processed Products 109
Cost of Fruit for Processing 110
Outlook 110
Some Historical Comparisons 112
Conclusions 115

Appendix 1 - Conversion Rates for Italian Lire, 1913-49 . . .116
Appendix 2 - Analysis of Lemon Oils 117

INTRODUCTION

The Italian citrus industry is an ancient one, and evidence exists that citrus of some type or other has been planted in this region since Roman times.

Many Italian lemon orchards are 75 years of age, with individual trees on root stock at least 100 years old. Since all of the Italian orchards are cultivated by hand, greatest attention is paid to the details of cultivation and tree care, and even the old trees in the orchard seem to have excellent vigor.

The climatic conditions under which citrus is produced in Italy and Sicily are practically ideal, the climate being very gentle and mild for most seasons of the year.

The citrus processing industry in Italy is also an ancient one. Essential oils, neroli or orange-flower oil, orange-flower water, and petit grain, which is the essence obtained by boiling orange leaves, are all old processed products. This is not surprising, since at one time the Moors made their culture felt on this area, and these nonfruit processed products are traditional with their culture. This may explain why the bitter orange industry, which is the source of many of these nonfruit processed products, is found in the vicinity of Siracusa, the ancient center of culture in Sicily.

With centuries of experience, the Italian citrus grower is extremely capable, and the verdelli practice, by which summer lemons are produced, is probably the most complicated citrus practice used commercially anywhere in the world. Success with this type of culture demands a very high degree of control over all factors of cultivation, such as moisture, fertilization, and tillage. The quality of citrus fruits raised is generally excellent, and the United States citrus industry has nothing comparable to the fine blood oranges grown on the slopes of Mt. Etna.

This study of Italian citrus industry was made during the late summer of 1949, beginning in Palermo on August 19. A motor car trip was made to the districts of Carini, Monreale, and Bagheria, in the vicinity of Palermo, on the island of Sicily. Visits were also made to the most important citrus processing plants in the vicinity of Palermo. The trip from Palermo to Messina was made by train which runs along the coast line, passing the more important citrus plantings near Agata and Barcellona. The coastal citrus districts, south to Taormina, were visited by motor car. Out of Catania, the citrus districts and the experiment station at Acireale were visited and a motor trip was made to the interior citrus areas, which lie along the River Simento below Paterno, and to the orange districts in the vicinity of Adrano. The orange districts at Francofonte and Lentini were visited on a motor drive southward to the citrus districts in the vicinity of Siracusa. South of Siracusa, districts of minor plantings of lemons were visited as far south as Noto.

Across the Straits of Messina, the essential oils laboratories at Reggio were visited and a trip was made by motor car to the bergamot orchards in the vicinity of Reggio. Citrus districts along the Italian coast were seen from the rail line between Reggio and Naples. The most important of these districts are at Rosarno, Francavilla, Fiumefreddo, and Salerno.

From Naples, a motor trip was made to the lemon districts on the Sorrento Peninsula, and citrus packing houses at Piano Sorrento were visited.

The route of travel in the citrus areas is given here in some detail, in order that the areas which were personally visited may be kept in mind as the report is read.

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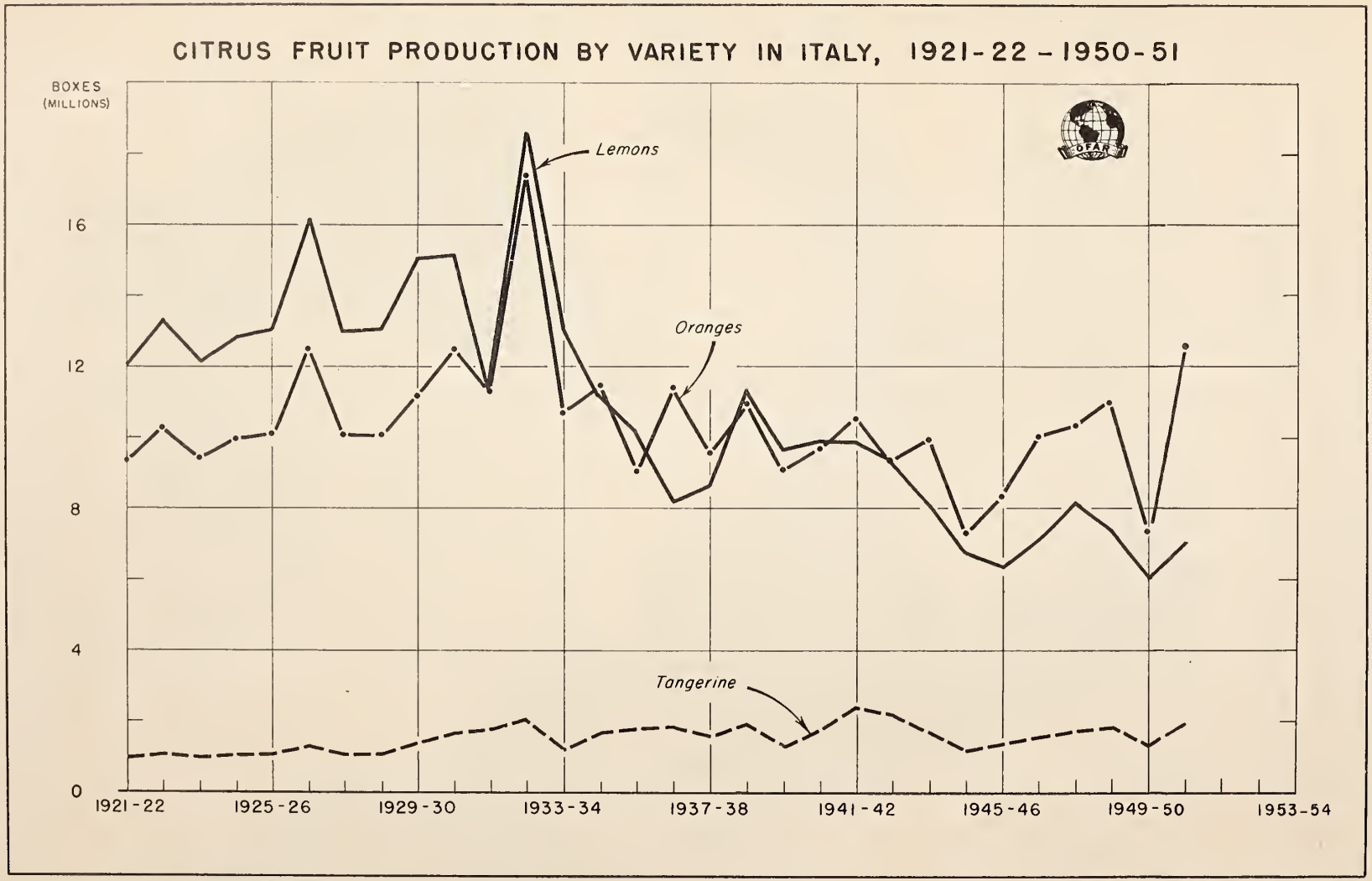
CITRUS FRUIT PRODUCTION BY VARIETY IN ITALY, 1921-22 - 1950-51
BOXES (MILLIONS)
16
12
8
4
0
Lemons
Oranges
Tangerine
1921-22
1925-26
1929-30
1933-34
1937-38
1941-42
1945-46
1949-50
1953-54
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SUMMARY

Production

The production of lemons in Italy has declined since 1921, and today's production is approximately one-half that of 30 years ago. This decline in production is due primarily to the destruction of producing acreage by the fungus disease mal secco.

The production of tangerines and oranges was remarkably stable from 1921 to 1950 with the highest production being reached in the season of 1932-33. Production of these fruits increased to 17.6 million boxes in the 1950-51 season and may increase further as new plantings come into production and oranges and tangerines replace some of the lemon orchards destroyed by mal secco.

Exports

Lemon exports declined from a peak of nearly 8 million boxes in 1933 to about 6 million boxes in 1939, and during the war they fell to less than 1 million in 1944 and 1945. Since 1945, exports have increased, but the 1949 level of over 5 million boxes is not likely to be exceeded in the near future because of the limitations of production.

Orange exports followed a different pattern. They increased rapidly between 1932 and 1941, and in the latter year over 5.5 million boxes were exported. During the war years, 1943, 1944, and 1945, exports decreased to less than one-half million boxes per year. Since 1945 orange exports have recovered steadily reaching nearly 4.7 million boxes in 1950. In the future, this level of exports will probably be exceeded as production increases.

Tangerines were a minor export variety in the prewar years only slightly exceeding one-half million boxes in 1938 and being less in other prewar years. From 1943 through 1945 exports practically stopped. Since 1946, however, exports have greatly exceeded prewar levels. The 1950 export of 1,433,000 boxes is the highest on record and will probably be exceeded in the future as production increases.

Trade agreements have been negotiated with the major countries which are consumers of Italian citrus, whereby Italy furnishes citrus and other products in exchange for other commodities imported from purchasing countries. Normal trade is gradually replacing exports under trade agreement, and trade with England is on a commercial basis of negotiation between English importers and Italian exporters.

Cultural Practices

The Italian citrus industry is an irrigated land culture of primarily small groves of two acres or less. The industry is located in favorable climatic coastal zones in Sicily and the Italian peninsula. For the most part the climate is extremely favorable to citrus, but damaging wind storms and frosts do occur.

Most groves are closely planted, and mixed plantings are frequent. Sour or bitter orange rootstock is used almost exclusively in all districts.

Pruning is practiced in orange, lemon, and tangerine groves. Fertilization is important because of the intensive utilization of land, and common practice is to apply manure every 3 or 4 years and simple nitrates each year as they are available.

Pests and diseases cause considerable damage, and pests are controlled by hand-applied oil sprays. The most important disease affecting the production of lemons is mal secco (Deuterophoma tracheiphila Petri), a tree-killing fungus disease for which there is no control other than to prune away diseased areas of the tree or to plant resistant varieties of lemons such as the Monachello. This disease has destroyed about half of Italy's lemon groves in the past 15 years. Gummosis and Phytophthora are also serious diseases.

The most interesting cultural feature of the Italian lemon industry is the verdelli practice of withholding irrigation water on some groves in late June until the trees almost wilt, then in late July or August applying chemical fertilizer and renewing irrigations. This shocks the tree into an artificial bloom which produces a summer lemon called a verdello.

Varieties

None of the commonly known United States citrus varieties are of any commercial importance in Italy. The most important Italian orange is the Ovale, which is a nonblood fruit; however, the Italian blood varieties, particularly the Tarocco and Sanguinello are known for their fine quality.

Italian lemon varieties are also different from those common to United States citrus orchards, and the new varieties resistant to mal secco such as the Monachello, are unknown to American citrus growers.

Production Costs

The cost of producing and packing lemons in Italy is lower than in the United States and Italian lemons are highly competitive in both European and United States markets.

In 1949 the estimated cost of production of Italian lemons at the grove varied from 63 cents to $1.05 per 66-pound box and from 74 cents to $1.23 per 76-pound box. The cost of packing Italian lemons is estimated to range between 86 cents and $1.14 per 66-pound box and between 99 cents and $1.31 for a 76-pound box. The break-even cost in 1949 of a packed box f.o.b. Italian ports, considering the cost of production and the cost of packing, may be estimated to range between $1.49 and $2.19 per 66-pound box, and from $1.73 to $2.54 for a 76-pound box.

Processing

Processing has always been important to the Italian citrus industry, and particularly to the production of lemon processed products. Historically a large percentage of Italian lemon production has been disposed of as processed products, and at one time over 50 percent of all lemons produced in Italy were utilized for some kind of processing, particularly the manufacture of citric acid. At present, citric acid is declining in importance, as other means of producing this chemical have been discovered. Essential citrus oils, peel products, fruit juices, and pectin are all major products. The mal secco resistant lemons, which are replacing the old varieties, are less acid and have less essential oil in the peel. Production of natural lemon oil may therefore be expected to decrease. In the future a modernization program will probably result in citrus juices, both single-strength and concentrated, and pectin becoming far more important than they have been in the past.

Lemon juice will probably be more important than orange juice, as the presence of the Mediterranean fruit fly and the predominance of blood varieties will limit the expansion of an orange juice industry.

In the next few years the export demand for fresh lemons will reduce the quantity of lemons available to processors.

CITRUS PRODUCTION

Between 1921-22 and 1950-51 a marked change occurred in Italy's citrus production. Lemon production exceeded orange production by 2 to 3 million boxes a year until 1932-33. In that year production of both crops reached an all-time high (18,598,000 boxes of lemons and 17,324,000 boxes of oranges), and the gap between the production of the two varieties was smaller than in the past. From 1932-33 to 1940-41, the industry was in a transition period; lemon production declined, and in some years more oranges than lemons were produced and in other years lemons were the larger crop. From 1940-41 to 1950-51 a new pattern of production was apparent with the production of oranges exceeding that of lemons in every year.

Orange production has increased since 1941-42; the 1950-51 crop of 15,259,000 boxes, the largest since 1932-33, is over 8 million boxes more than the 1950-51 lemon crop and over 5 million boxes more than the orange crop of 1940-41. Lemon production, however, has declined, and the 1950-51 crop of 6,469,000 boxes is less than the crop of 1940-41 by 3 million boxes.

The primary reason for this change is the tree-killing fungus disease, mal secco, which has destroyed many lemon orchards. Orange acreage has been expanded in new districts and in the lemon producing areas because the sweet orange is resistant to the disease. This change, which has been going on for 15 years or more, is apparent in the production levels and is confirmed by the plantings of oranges and destruction of lemon trees observed in the citrus producing areas.

Orange production has been reasonably steady since 1921-22 and is now increasing, but lemon production increased until 1932-33 and has declined ever since.

Tangerine production, like that of the orange, has been fairly constant. It has tended to increase since 1921-22, and new plantings which are being made in the lemon areas of Sicily will probably bring a further increase in the future. The tangerine is being planted because it is resistant to mal secco.

In the future, the production of oranges will increase and may exceed 15 million boxes each year when newly planted acreage comes into bearing in a few years.

Lemon production should remain at about the present level because the new plantings of lemon varieties such as the Monachello, which are resistant to mal secco, will about replace the area destroyed each year. The production of lemons will probably range between 6 million and 8 million boxes per year for some time. There are no indications at this time of any major increase in the production of lemons.

These data on production clearly indicate the changes which have taken place, but the acreage statistics do not reveal the increase in sweet orange and tangerine acreage and the reduction in lemon acreage which will create the pattern of future production in Italy.

Table 1. - Italy: Citrus Fruit Production, 1921-22 to 1950-51 1/

Season	Variety		
	Oranges	Tangerines	Lemons
	1,000 boxes	1,000 boxes	1,000 boxes
1921-22	9,323	937	12,067
1922-23	10,287	1,034	13,316
1923-24	9,387	943	12,150
1924-25	9,967	1,002	12,801
1925-26	10,105	1,015	13,080
1926-27	12,477	1,254	16,151
1927-28	10,055	1,010	13,015
1928-29	10,073	1,012	13,038
1929-30	11,140	1,349	15,079
1930-31	12,482	1,650	15,154
1931-32	11,281	1,759	11,283
1932-33	17,324	2,057	18,598
1933-34	10,688	1,179	13,024
1934-35	11,463	1,638	11,155
1935-36	9,008	1,761	10,253
1936-37	11,426	1,861	8,247
1937-38	9,527	1,597	8,662
1938-39	10,966	1,968	11,330
1939-40	9,092	1,298	9,694
1940-41	9,615	1,751	9,897
1941-42	10,510	2,412	9,860
1942-43	9,322	2,211	9,202
1943-44	9,952	1,669	8,092
1944-45	7,311	1,178	6,784
1945-46	8,377	1,398	6,373
1946-47	10,059	1,580	7,138
1947-48	10,394	1,700	8,136
1948-49	11,115	1,805	7,386
1949-50	8,277	1,571	6,768
1950-51	15,259	2,337	6,469

1/ Oranges and tangerines in boxes of 70 pounds; lemons, 76 pounds.

CITRUS ACREAGE

The primary purpose of presenting acreage data is to identify the more important citrus districts. The figures in Tables 2, 3, and 4 are probably as reliable a record of acreage as can be obtained. However, they should be interpreted in terms of their limitations. First, the nature of the Italian citrus industry with its many small property holdings and mixed planting makes exact acreage tabulation very difficult. Secondly, because of World War II records are not yet always complete or up-to-date. Thirdly, after the war, fertilizers had to be allocated, and registered citrus acreage was one of the bases used. Under the circumstances, it was to the advantage of the grower to register as much acreage as possible, and there was no incentive to change acreage registration when trees were removed because of their destruction by mal secco. Consequently, in many cases the acreage figures include the old registered acreage plus the new plantings, and land which is now used for other crops is still registered as lemon acreage.

The total acreage figures should be considered as only an approximate indication of the extent of the industry, and are probably correct within limits of 25 percent.

Lemon Acreage

Most of Italy's lemons are produced in Sicily, in the provinces of Messina, Palermo, and Catania, and it is believed that these provinces will continue to be the areas of highest production.

According to the records the total lemon acreage increased from 65,007 acres in 1936 to 69,346 acres in 1948, with mixed culture representing about 1/7 of total lemon acreage in 1948. Observations in the field, however, indicate that present total acreage is at least 25 percent below that of 1936, or approximately 48,750 acres, with mixed plantings accounting for a higher proportion of the lemon acreage. In Messina and Catania, for instance, the records show increases in lemon acreage since 1936, and none in mixed culture, yet about half the orchards are said to have been destroyed by mal secco, and replanted in some cases as mixed plantings. It is believed that the registration factors mentioned above account for the discrepancies between recorded acreage and actual plantings.

Since the new lemon plantings about replace the areas destroyed each year by mal secco, no prospective major increase in lemon acreage is apparent at this time.

Orange Acreage

Orange plantings are much more scattered than lemon plantings, and the major areas of orange production are the provinces of Catania and Siracusa in Sicily and the provinces of Campania and Calabria on the Italian peninsula. New planting is continuing in newly developed areas in the province of Catania and in areas where lemon trees have been destroyed by mal secco.

Table 3 shows an increase in Italian orange acreage from 70,235 acres in 1936 to 82, 471 acres in 1948. Acreage has increased, but the 1948 figures seem high on the basis of acreage seen, production level, and probable yield per acre. The actual planted area is believed to be somewhat less than the recorded total, in spite of recent acreage expansion by new plantings.

Tangerine Acreage

Tangerines are grown largely in Sicily, in the provinces of Palermo, Catania, and Siracusa; very little acreage on the Italian peninsula is devoted to this variety.

The increase in recorded acreage of tangerines in Sicily from 23,930 acres in 1936 to 26,928 acres in 1948 seems reasonable. Visits to the producing areas in Sicily indicated that acreage has increased in the last 10 years, the largest increase having occurred in lemon producing provinces such as Messina and Catania. In many orchards, tangerine trees were interplanted with lemon trees as a "hedge" against the destruction of the lemon orchard by mal secco.

Table 2. - Italy: Lemon Acreage, Annual 1936-37 and 1945-48

Province	1936	1937	1945	1946	1947	1948
	Acres	Acres	Acres	Acres	Acres	Acres
	Specialized Culture 1/					
Italian Peninsula:						
Liguria	230				17	15
Lombardia-Toscana	25				37	37
Lazio	477				410	410
Campania	1,611				1,611	1,611
Puglie	783				489	489
Calabria	724				731	707
Total	3,850				3,295	3,269
Sicily:						
Agrigento	590	590	591	591	591	591
Caltanissetta	---	---	---	---	---	---
Catania	14,747	14,747	14,747	14,747	14,747	14,747
Enna	---	---	---	---	---	---
Messina	16,776	16,341	20,702	20,702	20,702	20,702
Palermo	13,914	13,914	17,767	16,897	16,897	15,216
Ragusa	62	62	49	49	49	49
Siracusa	5,026	5,026	5,041	5,036	5,036	4,725
Trapania	106	106	106	106	106	106
Total	51,221	50,786	59,003	58,128	58,128	56,136
	Mixed Culture 2/					
Sicily:						
Agrigento	783	783	783	783	783	783
Caltanissetta	1,001	1,001	1,003	1,003	1,003	1,003
Catania	5,065	5,065	5,065	5,066	5,066	5,066
Enna	---	---	---	---	---	---
Messina	655	655	655	655	655	655
Palermo	193	193	193	128	128	128
Ragusa	798	798	865	865	865	865
Siracusa	---	---	---	---	---	---
Trapania	1,441	1,441	1,441	1,441	1,441	1,441
Total	9,936	9,936	10,005	9,941	9,941	9,941

1/ Crops other than citrus are not raised in the orchards.
2/ Other noncitrus crops are raised in the orchards.

Source: Regional Inspectorate for Agriculture, Palermo.

Table 3. - Italy: Orange Acreage, Annual 1936-37 and 1945-48

Province	1936	1937	1945	1946	1947	1948
	Acres	Acres	Acres	Acres	Acres	Acres
	Specialized Culture 1/					
Italian Peninsula:						
Liguria	158				141	141
Tuscany	47				45	49
Lazio	2,221				2,278	2,901
Abbruzzi and Molise	79				59	59
Campania	6,202				6,202	6,202
Puglie	1,332				1,688	1,695
Lucania	467				776	776
Calabria	16,879				17,779	17,888
Sardinia	1,841				1,945	1,989
Total	29,226				30,913	31,700
Sicily:						
Agrigento	2,021	2,011	2,021	2,021	2,021	2,021
Caltanissetta	386	386	395	395	395	395
Catania	13,259	13,259	13,259	13,259	15,978	15,508
Enna	3,929	4,003	4,448	4,448	4,448	4,448
Messina	3,677	3,677	3,511	3,511	3,511	3,511
Palermo	2,365	2,365	2,365	2,281	2,281	2,328
Ragusa	541	541	855	855	961	961
Siracusa	8,451	8,451	10,364	14,419	14,418	14,631
Trapania	1,658	1,658	1,658	1,658	1,658	1,658
Total	36,287	36,351	38,876	42,847	45,671	45,461
	Mixed Culture 2/					
Sicily:						
Agrigento	640	640	640	640	640	640
Caltanissetta	27	27	30	30	30	30
Catania	756	756	756	756	756	756
Enna	---	---	---	---	---	---
Messina	2,289	2,289	2,289	2,289	2,289	2,289
Palermo	798	798	798	852	852	852
Ragusa	106	106	370	370	370	637
Siracusa	---	---	4,065	---	---	---
Trapania	106	106	106	106	106	106
Total	4,722	4,722	9,054	5,043	5,043	5,310

1/ Crops other than citrus are not raised in the orchards.
2/ Other noncitrus crops are raised in the orchards.

Source: Regional Inspectorate for Agriculture, Palermo.

Table 4. - Italy: Tangerine Acreage, Annual 1936-37 and 1945-48

Province	1936	1937	1945	1946	1947	1948
	Acres	Acres	Acres	Acres	Acres	Acres
	Specialized Culture 1/					
Italian Peninsula:						
Campania	267				316	316
Puglie	27				712	761
Calabria	52				143	170
Total	346				1,171	1,247
Sicily:						
Agrigento	12	12	12	12	12	12
Caltanissetta	---	---	---	---	---	---
Catania	1,631	1,631	1,631	1,631	2,681	2,375
Enna	---	---	---	---	---	---
Messina	126	126	114	114	114	153
Palermo	3,813	3,813	6,301	6,424	6,445	6,494
Ragusa	---	---	5	5	12	12
Siracusa	161	161	222	225	225	257
Trapania	---	---	---	---	---	---
Total	5,743	5,743	8,285	8,411	9,489	9,303
	Mixed Culture 2/					
Sicily:						
Agrigento	942	942	941	941	942	942
Caltanissetta	40	40	42	42	42	42
Catania	8,258	8,258	8,258	8,258	8,258	8,258
Enna	---	---	---	---	---	---
Messina	2,394	2,394	2,394	2,394	2,394	2,394
Palermo	74	74	74	49	49	49
Ragusa	37	37	99	99	111	210
Siracusa	5,715	5,715	4,065	3,991	4,065	4,102
Trapania	381	381	381	381	381	381
Total	17,841	17,841	16,254	16,155	16,242	16,378

1/ Crops other than citrus are not raised in the orchards.
2/ Other noncitrus crops are raised in the orchards.

Source: Regional Inspectorate for Agriculture, Palermo.

CITRUS DISTRICTS

Sicily

The citrus districts of Sicily are widely scattered and differ considerably in character.

Palermo. Near Palermo are three primary districts: one in the vicinity of Carini, another a few miles inland from Palermo in the valley near Monreali, and the third in the valley in the vicinity of Bagheria. Lemons in these areas are planted 600 to 650 to the hectare (243 to 263 trees to the acre) and the tangerine trees, being very small, are planted as closely as 800 to the hectare (324 trees per acre). The majority of the plantings are on valley floor; however, there are some terraced plantings on the sides of the valleys. In these districts lemon trees grow to a large size, and it is not difficult to find trees that are over 100 years of age. Irrigation is expensive, since it is sometimes necessary to pump the water to high elevations in 8-inch steel pipes. It is not unusual to find orchards where water is pumped 500 feet to irrigate the uppermost part of the garden. A furrow-type irrigation is followed by which the entire area between trees receives water. From the evidence of the height and vigor of the trees, they seem to be in healthy condition and receive adequate fertilizer.

There are climatic differences between the districts of Bagheria and Palermo. Bagheria has far fewer pests than has the more humid area of Palermo. All these areas have been infested with mal secco, but only in the vicinity of Palermo has there been any extensive damage.

Barcellona. Narrow citrus districts occur along the coast between Agata and Barcellona. Most plantings are within 1 or 2 milles of the sea, and plantings extend inland only along broad valleys adjacent to water courses. The plantings near Palermo are primarily tangerines; around Barcellona they are more mixed. A considerable area has been planted to oranges within the last 5 years. The cultural practices in Barcellona differ from those in Palermo: trees are planted farther apart; they are pruned to a more normal tree shape; and irrigation water is applied in a basin immediately around the tree trunk, leaving a dry area in the middle. Some of the rivers have a rapid flow, and high stone walls are constructed along the edge of the rivers to protect the groves. This area is much more humid than Palermo and receives at least double the rainfall.

Messina. The Messina citrus districts extend from the edge of town along the coast and up into the river valleys to the vicinity of Taormina. This area was planted almost entirely to lemons until the destruction of

many of the older groves by mal secco. Lemons still predominate, and most of the old trees are being replaced by a resistant variety of lemon, the Monachello; however, some lemon trees are now being replaced by tangerine trees, particularly in mixed plantings.

Catania. Continuing along the coast, the next citrus district begins at Fiumefreddo and continues to Catania. This is a narrow planting, almost entirely of lemons, located along the fertile coastal slopes of Mt. Etna. Other crops, such as grapes and vegetables, are raised, and many plantings are a mixed culture. The old trees in this area reach a height of 25 feet, and many of them seem to be very old, some nearly 100 years. There are no citrus plantings in the immediate vicinity of Catania.

Paterno. A large orange district is found in the river valleys below Paterno. This area consists almost entirely of oranges and is the home of the famous Sanguinello variety. Although the orchards are cultivated by hand, the trees are planted farther apart, being only about 400 to the hectare. Irrigation water is applied by means of furrows, a system similar to the practice near Palermo. In orchards near the Simeto River, gravity water for irrigation is available. The interesting thing in this district is the rather extensive new plantings of oranges, which will increase production in the next 5 years.

Adrano. In the Simeto River valley near Adrano is another orange district with many new plantings. Unlike most other areas of Sicily, this valley has gravity water, and it is not unusual to see a wide stream of clear mountain water flowing in the vicinity of citrus plantings. In new orchards the trees are planted farther apart than in the old orchards--about 400 trees per hectare. Cultivating work is still done by hand.

Lentini and Francofonte. The first orchards south of Catania lie in the valleys below and around Lentini, and continue up the valley to the vicinity of Francofonte. These plantings are primarily orange, and, as at least 20 percent of the orchards have been planted within the last 8 years, a large increase in production may be expected from this district.

Siracusa. The river valleys along the coast between Lentini and Augusta are planted primarily to lemons, and larger plantings of lemons are found on the plain north of Siracusa. In this area the new plantings of oranges and the new tangerine plantings in existing lemon orchards are indicative of the grower's fear of the destruction of his property by mal secco. In this area and in the small citrus plantings towards Noto, bitter orange trees are often planted around the lemon groves. The blossoms and leaves of the bitter orange are utilized for the production of neroli and petit grain. None of the plantings observed were of great age. However, it is believed that some of the earliest citrus plantings in Sicily were located near Siracusa and that citrus has been raised in this vicinity since the year 1000.

Italian Peninsula

The citrus districts on the Italian peninsula differ in character from those of Sicily. In the southermost part of the region of Calabria and in the vicinity of Reggio are large plantings of the bergamot, which is a lemon-type fruit utilized for the production of essential oils and citric acid. Primary plantings are located along the river valleys beyond Reggio and in the valley near Villa San Giovanni. In this southern area there are also plantings of orange and tangerine trees in small, widely-scattered areas.

Along the coast, plantings consisting primarily of oranges and tangerines are found near Gioia, Tauro, Rosarno, Vibo, Francavilla, San Pietro, Cetraro, Diamante, and as far north as Genoa, and a larger orange district is to be found near Salerno. Considerable plantings of lemons and oranges are found on the Sorrento peninsula south of Naples, and scattered citrus plantings are located in favored areas between Naples and Rome, one of the largest districts being in the vicinity of Fondi. However, the districts between Naples and Rome are not as well cultivated as those in the southern areas.

The coastal plantings of Italian citrus groves are adjacent to water courses near the sea or in the flat coastal plains as are found near Salerno.

Sorrento. One of the most interesting citrus districts is on the Sorrento peninsula, south of Naples. This is a beautifully situated, mountainous peninsula, with elevations of at least 3,000 feet close to the sea. The main crop is lemons, but oranges and tangerines are also raised. This is an intensive cultivation, with every available foot of land being utilized. The citrus orchards are located in the valleys on the north side of the peninsula and are found from near sea level to heights of almost 1,500 feet.

A unique cultural practice is followed to protect the groves from frost. All the citrus is raised under a framework of poles with lateral cross pieces at the top approximately 5 feet apart. In winter mats are laid on top of the poles to cover the entire orchard.

Other crops, such as walnuts, olives, grapes, and vegetables, are raised in the citrus orchards. It is not unusual to see a grove with products being raised on five levels: walnuts on tall trees 35 feet above the ground, grapes trained on the framework over the citrus trees, the main crop of citrus below the framework, tomatoes on the ground, and finally root crops, such as potatoes.

Trees are planted rather close together, the common planting distance being "24 palms," 12 to 15 feet apart.

An unusual type of irrigation process is followed. A basin 8 feet in diameter is dug around the tree, and there is a high mound of earth between each tree. As in Sicilian orchards, all cultivating and spraying is done by hand.

Fruit raised on Sorrento is usually packed on the peninsula. Piano Sorrento, a small town approximately 3 miles inland from Sorrento, is the location of two packing houses and the headquarters of most packers and exporters. The packed fruit is taken by truck to Naples, and export shipments are made from this port. There is no processing industry on Sorrento, since culled fruit is sold for fresh consumption either in the vicinity of Naples or in Rome.

CLIMATE

The climate in the southern part of the Italian peninsula and in Sicily is extremely mild and highly suited to the production of citrus fruit. In Sicily the even temperature and humidity seem ideal for the production of lemons; in some sections the climate is so mild that bananas will ripen. On the whole, the climate is more temperate than in the majority of the California lemon producing areas. In the California citrus districts, the temperature range is greater, with higher and lower extremes; the humidity is lower; and the winds from the Pacific are stronger than those from the Mediterranean.

Rainfall

There is some variation in rainfall between districts, the average rainfall is approximately 29 inches a year in Palermo, slightly over 30 inches near Messina, and approximately 34 inches at Naples. The heaviest periods of rainfall are from October to March. In some years there is intermittent rainfall during the spring and summer months; however, this is usually a negligible quantity and insufficient to eliminate the necessity for irrigation.

Table 5. - Italy: Rainfall at Palermo and Naples by Months 1940 1/

Month	Palermo	Naples
	Inches	Inches
January	10.2	6.9
February	3.6	2.5
March	3.0	0.4
April	4.8	2.2
May	10.0	1.1
June	1.8	1.3
July	2/	1.3
August	1.8	0.7
September	0.1	0.4
October	5.0	7.3
November	1.3	2.9
December	12.7	2.9
Total	54.3	29.9

1/ 1871-1937 average: 28.9 inches at Palermo and 34.0 inches at Naples.
2/ Not available.

Temperature

The monthly range of temperatures (see Table 6) indicates the mildness of the climate. The daily range is seldom greater than 20 degrees in winter, and is usually less than 15 degrees in summer.

Table 6. - Italy: Minimum and Maximum Temperatures at Naples, 1942 and Palermo, 1940

Month	Naples (1942)		Palermo (1940)	
	Minimum °F	Maximum °F	Minimum °F	Maximum °F
January	32	57	43	62
February	32	62.6	46	61
March	46	68	37.4	68
April	46	70	51	71
May	47	84	58	78
June	57	90	65	79
July	63	93.2	75	85.5
August	66	92	72.5	85
September	65	91.3	67	81.5
October	54	86	60	82
November	42	82	51	69
December	40	65	41	60

Frost

In spite of the mild climate, there is a frost hazard in Sicily and southern Italy, and damaging frosts occurred in March 1940 and again in March 1949.

The 1940 frost was particularly severe as the groves suffered extensive tree damage, in addition to loss of unharvested fruit.1/ In the territories affected (principally Lentini, Francofonte, Palagonia, Paterno, and Adrano in Sicily, and the Calabria region in southern Italy), the damage was fortunately limited to orange groves in the valleys; those on higher ground were injured either slightly or not at all. In one area near Palermo the frosts caused perceptible damage only to the tangerines by destroying the blossoms.

The nature of the frost aggravated the damage. The cold rain of the 9th and the cold wind of that night were followed by a hot sun the morning of the 10th; then came the second cold wave of 2 days' duration. The rapid succession of freezing, thawing, and freezing was more disstrous than the drop to below 0° C. would have been in itself.

1/ V. Carrante, La Gelata degli Aranceti nel 1940, Acireale Bollettino N. 74, R. Stazione Sperimental di Frutticoltura e di Agrumicoltura, Acireale.

Trees were affected to varying degrees, ranging from the loss of a few shoots, to the death of extensive parts of the top, and, in exceptional instances, to the death of the entire tree. In some cases, the entire year's crop was lost; in others, normal production could not be expected for 4 or 5 years.

The 1949 frost again affected the orange groves in the low valleys most severely. Groves in the vicinity of Paterno and Adrano suffered particularly. The lemon producing areas were only slightly damaged as they are located near the seashore and usually on terrain which has a good cold air drainage. The bergamot groves near Calabria were also damaged by this frost, but these are particularly susceptible to frost.

From the time of year at which the 1940 and 1949 frosts occurred, it would seem that March may be one of the months of greatest frost hazard in the Italian citrus areas. Frosts as severe as the one in 1940 are believed to represent an extreme climatic condition which may occur about once in 20 years.

Only on the Sorrento peninsula are steps taken to protect the groves against frost. There, protective mats are laid over a permanent framework of poles in winter.

CULTURAL PRACTICES

The Italian citrus cultural methods are reminiscent of those in Spain, and hand-digging is a primary method of cultivation. In the larger orchards, particularly in plantings of orange on the valley floors, team cultivation may be used in the rows between the trees, the areas under the trees being cultivated by hand. Only one tractor was seen in the citrus groves visited, and it was a very small type apparently used primarily for the hauling of equipment and fruit within the orchard itself. As in other areas of hand culture, intensive use is made of the land area, and the trees are closely planted.

Labor

The abundance of rather inexpensive labor makes hand cultivation possible. In 1949 the average daily wage for farm labor was approximately 700 lire ($1.22) per day. As an example of the labor load required for the operation of a property, a rather large grove, which probably made more effective use of labor than some of the smaller operations, required 38 man days per acre per year for operation. Part of this grove was very closely planted so that the ground was shaded, eliminating the growth of weeds, and this accounted, at least partly, for the lower labor load required.

In the accompanying tabulation of the labor load in two groves near Sorrento a higher labor load is indicated, one grove requiring 234 man days per hectare (95 man days per acre) per year and the other grove 339 man days per hectare (137 man days per acre) per year (see Table 7). These labor loads may be considered as more typical of the average small grove.

Since the citrus industry is an old one in Italy, skilled labor is available for cultivation, and for work on disease control, tree propagation, spraying, and fertilization. For grove operations such as pruning and harvesting regular farm help is also utilized. In small groves operated by the owners or a renter, the entire family participates in some of the cultural operations.

Table 7. - Italy: Yearly Requirements of Manpower per Hectare in a Citrus Grove

Type of Work	Masselubrense				Amalfi			
	Man	Woman	Boy	Total	Man	Woman	Boy	Total
	Days	Days	Days	Days 1/	Days	Days	Days	Days 1/
Hoeing	67	-	-	67	50			50
Digging holes	27	-	-	27	26	-	-	26
Fertilizing	2	9	4	9½	17	-	-	17
Transportation of fertilizers	-	-	-	-	-	21	-	13
Spraying	3	1	-	3½	4	6	-	8
Pruning	45	-	-	45	26	-	-	26
Tying of branches	-	-	-	-	30	-	-	30
Placing of tree covering	9	-	27	22½	21	-	43	42½
Removal of tree covering	4	-	13	10½	21	-	30	36
Transportation of branches	-	-	-	-	-	85	-	51
Lemon picking	41	13	-	49	32	-	15	39½
Total	198	23	44	234	227	112	88	2/ 339

1/ Man working day is 8 hours. Woman working day is equal to 0.6 man working day. Boy working day is equal to 0.5 man working day. Total is given in man working days of 8 hours.

2/ According to Professor Allessandro Brizi of the University of Naples, a student of agricultural conditions in Compania, manpower requirements per hectare equal 465 working days per year. This estimate has been considered as too high by farmers in the area. The above data were gathered on the spot. Although labor requirements on some particular farms exceed the totals given above, these nevertheless represent a fair estimate under average conditions.

Source: A report of the American Consul at Naples, Italy.

Mixed Culture

The density of population and the restricted areas of land suitable for irrigated culture make it necessary to practice intensive land use, and as many as five crops may be seen in an orchard at one time. Some of the land devoted to citrus culture is very fertile, and it is possible climatically to raise several crops during the year. It is not unusual to see large olive trees which are pruned so that their leaf surface is above the trees in a lemon grove. In certain areas, walnut trees are grown in a similar manner, with the leaf surface sometimes as much as 35 feet above the ground. Peaches, pears, and other deciduous fruits and

figs are also interplanted with lemons, and grapes and row crops are produced in season in most gardens. This very intensified agriculture is made possible by the use of hand labor. Utilization of tractors would require a greater specialization in the crops grown, and a reduction in crop area, as much of the land now utilized by hand cultivation could not be cultivated with power-drawn tools.

An extreme example of the practice of mixed culture was seen on the Sorrento peninsula near Naples where five crops were raised in a grove at one time. In this district every grove is covered by a framework of poles upon which straw mats are placed in winter to protect the grove against cold. Grapevines were trained along the poles, and grapes were grown as the second crop. Large walnut trees were planted in the grove and were trimmed very high with the leaf surface well above the framework of poles covering the citrus grove. On the surface of the ground tomatoes and other row-crop vegetables were being produced, and in the ground were such tubers as potatoes, thus making, in all, five crops on five different levels, indeed an intensive agriculture.

Most of the Italian citrus groves must not only raise a cash crop for their operators, but must also produce a substantial quantity of the family foodstuff. This practice of mixed culture is a very complicating factor in estimating the production of a grove, for an important portion of grove income is obtained from crops other than citrus. When the real value of these crops is taken into consideration, the cost of citrus production is reduced to a considerable degree.

Planting Distance

The distance at which citrus trees are planted depends upon district and terrain. The most closely planted groves of tangerines and lemons were observed in the vicinity of Palermo. There, in older orchards, lemons were planted 600 to 650 trees to the hectare (243 to 263 trees to the acre), and tangerines were even more closely planted, averaging 800 trees to the hectare (324 trees per acre). In these closely-planted orchards, most of the tangerine trees were dwarf in size, and 10-year-old trees were observed which were not more than 7 feet tall. A pattern of close planting and high pruning is followed along the coast of Sicily from Palermo to Messina. In this entire district both lemon and tangerine trees are planted approximately 10 to 12 feet apart in most orchards.

In the plantings along the coast between Messina and Catania, a different planting distance is practiced. In the terrace plantings where most of the verdelli lemons are raised, the planting distance along the rows may be only 10 to 12 feet, and the distance between terraces may be approximately 20 feet. The lemon groves near the seashore are located on relatively level land; here, the trees are larger and are planted at greater distances than is the case on on the Palermo coast. Planting distances, even in old orchards, are approximately 20 feet.

Planting distances for oranges are about the same as for lemons, although the orange trees do not grow as large as the lemon trees and are pruned differently. The Italian orange trees are small by United States standards, few being taller than 12 feet. In the orange districts of Paterno and Adrano, inland from Catania, at least 150 trees are planted to the acre.

Pruning

Pruning practices vary primarily in accordance with the planting distances. In the vicinity of Palermo, where the groves are closely planted, trees are pruned high in an upright manner so it is possible to walk under them, even close to the trunk. The entire orchard is covered by the tree tops, and, since the tops of the trees are pruned flat, the foliage gives the appearance of an arbor. The pruning might be called a group pattern pruning, since it is impossible to differentiate between individual trees. In lemon groves observed near Palermo, in addition to the lower limbs being removed in order to raise the skirts of the trees, the top foliage is pruned heavily at least once during the year. This reduction of foliage might be necessary due to the close planting of the orchards. In the lemon areas toward Messina and Catania where trees are planted at greater distances, the tree is opened up to admit sunlight, and each tree is separated from the others.

Tangerine trees are pruned to admit light. Orange trees are not pruned as heavily as lemon trees; in most districts they are kept in their natural shape, with the skirts close to the ground.

The trees are pruned in the early spring. The foliage removed from the bitter orange tree is utilized in the manufacture of petit grain, the foliage from lemon and orange trees is used for fodder for domestic animals, and the larger wood is used for firewood.

Since the fungus disease, mal secco, has become serious in Italian lemon orchards, the problem of pruning has been increased. To control the disease, groves must be constantly inspected and infected areas promptly removed. If the fungus is under the bark, the bark is removed so that the infection may be exposed to the sunlight and air to kill the invading fungus. This method of controlling mal secco is time-consuming and expensive.

Nursery Trees and Root Stock

As in other Mediterranean areas, the sour orange root is used almost exclusively. Tree propagation methods are changing as a means of protection against mal secco, and some growers are experimenting with a sweet "sandwich" of wood between the sour root and lemon top. Sweet orange is ordinarily used for this purpose; however, tangerine has also been observed.

Each grower raises his own nursery trees from seed, doing the budding and training. It is a general practice to bud quite high, from 1 to 2 feet from the ground, as protection against gummosis. Since the propagation of citrus is not centralized in commercial nurseries to any important degree, it is quite likely that there are varietal differences between districts. Therefore, in any one type of fruit, it would be most difficult to obtain pure strains of any one variety. It is entirely possible that many bud sprouts and mutations have been propagated when they exhibited what the orchard operator believed to be superior characteristics.

Trees planted in the winter may be planted bare root; in the spring and summer they are balled in the traditional manner.

A considerable portion of the citrus areas is devoted to nursery plantings, as the general expansion of the citrus industry, particularly new plantings of oranges and tangerines, and the replacement of mal secco killed lemon trees by resistant varieties has created the need for nursery stock. One garden of 45 hectares (111 acres) had a nursery with at least a thousand budded trees and many thousands of growing seedlings. Because of the very heavy planting of trees per acre, a great number of trees are necessary for the extension of plantings.

Tree replacement: Near Palermo, when it is necessary to replace a tree, the stump is dug out in winter, lime is put in the hole, and 8 inches of soil is added. Before replanting, the lime residue is removed and the top soil replaced. When trees are replanted in summer they are balled, the earth around the tree roots being held together by a basket.

Citrus has been raised in Sicily for nearly a thousand years, and old orchards have been replaced with new plantings quite successfully. Replants observed in orchards were usually vigorous, even in orchards where other trees were 100 years of age. The replacement program probably owes its success to the great care which each tree receives through hand-cultural methods, to the rich soil which has been enriched many times through volcanic action, and to the favorable climatic conditions which give the trees sufficient vigor to overcome many of the shocks of tree replacement.

Irrigation

All citrus plantings in Sicily and Italy are in irrigated culture, and indeed water is the lifeblood of the industry. The occasional summer rain provides some moisture, but the orchards depend on irrigation during the dry summer months. Since the areas planted to citrus are primarily on sloping ground, often on quite steep hills, the problems of irrigation are very complex. Some of these problems are reminiscent of those met in irrigating the terraced avocado orchards in southern California.

Groves located along water courses or near springs are irrigated by gravity water, which is obtained at small cost, but groves in this favorable situation are in the minority.

The majority of groves are irrigated by pumped water, which is often lifted under pressure to high elevations in order to irrigate the upper terraces of hillside plantings. Irrigation water obtained in this manner is very expensive because of the cost of installing the steel pipes and pumping equipment and the scarcity of fuel and electric power.

Not long ago, all citrus groves were irrigated by gravity water or by water pumped by donkey-powered installations. Under these conditions there was a limit to the elevations which could be irrigated. Now, with electric power and Diesel and gasoline engines, areas can be irrigated which had to be dry farmed before.

The extension of plantings because of power pumping is still going on, and the new lemon acreage observed near Roccalumera is on newly-developed high terraces built on the side of valleys which rise sharply from the seashore. This acreage should be free from frost because of the excellent cold air drainage, and the light gravelly soils will produce a fine quality lemon.

In visiting irrigation plants, one is surprised at the size of the machinery. Many of the old plants are run by gas engines which use coal gas as a fuel. While the actual pumping does not require much power, the power plant used to boost the water to a higher elevation is usually very large and expensive -- one grove had a 1,000 to 1,500 h.p. Diesel engine to furnish the necessary power, and the equipment and pumping plant might easily cost $25,000. This grove sells water to other growers at the rate pf 1,300 lire per hour for a flow of 40 cubic meters per hour, which is sufficient to irrigate 30 trees. Since there are approximately 600 trees to the hectare, the cost of water is 26,000 lire per hectare per irrigation, or $18 per acre at the current rate of exchange. At this rate the usual 5 irrigations would cost $90 per acre per year in this grove.

In another grove near Roccalumera on terraced plantings, water is purchased at the rate of 2,000 lire per hour for approximately 50 to 60 miner's inches, which is a flow of water sufficient to irrigate approximately 2.47 acres or 1 hectare in 3 hours. Here the cost is 6,000 lire per hectare per irrigation, or about $4.00 per acre per irrigation at the current rate of exchange.

At Carini, on the rather level valley floor, the irrigation practices are different from those near Palermo: At Carini there are long basins enclosing several trees; at Palermo one basin is used for each tree.

Near Palermo a grove visited was said to be irrigated seven times a year on the average, from March to September.

Within the groves, water is distributed by means of small, open-type Moorish ditches, and the irrigation tool is the short-handled, hoe-like implement which is used for cultivation. Water is controlled in the small ditch by means of a stick with a mop-like attachment of burlap. It is moved down the ditch to the place of diversion and held in place at the new point to be irrigated in order to dam the flow of water in the main channel.

This irrigation practice seems to be fairly adequate except that water is applied close to the trunks of the tree in most orchards, which would seem to increase the hazard of gummosis.

There are some undeveloped water resources in Sicily, particularly in the region of Catania. With proper dams to collect water in seasons of heavy rainfall, great areas could be brought under irrigation, and considerable acreage made suitable for the planting of citrus. Reclamation projects now under way in the vicinity of Catania will make available at least 12,000 hectares of such property.

Fertilization

Fertilization is extremely important to the Italian citrus grower owing to the intensive use of land, but the application of fertilizers is complicated by the mixed plantings of citrus and other crops.

An accepted fertilization practice in producing lemon groves is to apply 4 to 5 baskets (containing about 44 pounds each) of manure for each tree every 3 years, and 1½ to 2 kilos (3.3 to 4.4 pounds) of sulphate of ammonia and 1 kilo (2.2 pounds) of superphosphate each year. Considering that the customary planting contains approximately 600 trees per hectare (243 trees per acre) the above application would be 43,000 to 53,000 pounds of manure per acre every 3 years, 803 to 1,071 pounds of sulphate of ammonia per acre per year, and 535 pounds of superphosphate per acre per year.

Computing the costs of the above applications:

Manure. Manure at 40 lire per basket of approximately 44 pounds, 4 to 5 baskets every three years, costs 160 to 200 lire, 28 to 35 cents per tree per application or 1/3 of this per year or 39,600 to 31,880 lire per hectare ($22.43 to $27.87 per acre per year).

Superphosphate. 1 kilo (2.2 pounds) per tree per year or 600 kilos per hectare (535 pounds per acre) at 19 lire per kilo, 11,400 lire per hectare ($8.02 per acre).

Sulphate of Ammonia. 2 kilos (4.4 pounds) per tree per year or 1,200 kilos (2,646 pounds) per hectare at 49 lire per kilo, 58,800 lire per hectare ($41.38 per acre).

Summary. According to this practice the cost of fertilization may be summarized as follows:

Item	Lire per hectare	Dollars per acre
Manure (4 to 5 baskets per tree every 3 years @ 40 lire per basket)	31,880 - 39,600	22.43 - 27.87
Superphosphate (1 kilo (2.2 pounds) per year @ 19 lire per kilo)	11,400	8.02
Sulphate of ammonia (2 kilos (4.4 pounds) per tree per year @ 49 lire per kilo)	58,800	41.38
Total	102,080 - 109,800	71.83 - 77.27

This level of fertilization probably represents optimum conditions and the average fertilization costs are probably somewhat less than those indicated here.

Near Palermo, growers apply 1 kilo (2.2 pounds) of sulphate of ammonia per large tree and ½ kilo (1.1 pound) per small tree in summer. In winter they apply mixed fertilizer at the rate of 2 to 3 kilos (4.4 to 6.6 pounds) per large tree and 1 to 1½ kilos (2.2 to 3.3 pounds) per small tree. A representative mixture would be 50 percent superphosphate, 25 percent sulphate of ammonia, and 25 percent sulphate of potash.

Verdelli Practice

One of the most interesting practices is the manner in which verdelli, or summer lemons, are produced in Sicily. The highest production of Italian lemons is in the winter and spring months, with the fruit normally harvested in summer comprising only a small percentage of the total crop.

Verdelli is the term applied to Italian fruit which ripens during the months of July, August, and September, and is the summer lemon of Europe. The price of lemons in Europe, as in the United States, varies greatly with the temperature, the price rising rapidly during periods of short supply and extremely warm weather. The lemon trees normally produce a certain amount of the verdelli crop. However, since the verdelli is worth considerably more than the winter lemon, sometimes twice as much, it is in the interest of growers to raise as much of the summer lemon as possible. It has long been the practice in Sicily to create an artificial crop of the summer lemon (verdelli) by drying out trees in June and July until they begin to wilt and the leaves to fall. The trees are then fertilized and irrigated once or twice in rapid succession; this treatment brings about an artificial bloom resulting in the verdelli crop. This is considered a weakening process to the tree, but in the vicinity of Roccalumera it has been practiced year after year in the same groves. This type of

culture cannot be carried on under all conditions. It requires for best results a very light or sandy, gravelly soil. A terraced planting is particularly suitable, since two sides of the soil are exposed to the sun, and the process of drying out is more thorough and more easily controlled. When the verdelli crop is forced, it reduces the crop which is set in the winter time, and it is considered satisfactory if a grove sets two-thirds of its crop for winter lemons and one-third for verdelli. This is one of the most unusual practices and is a substitute for the method used to produce summer lemons in the United States, where the summer fruit is obtained by the cold storage of the fruit harvested in the springtime.

In September 1949, the verdelli bloom was observed in Sicily. The orchards had received an average of two irrigations since the end of the drying-out period, and there was no apparent injury to the trees. Quite a heavy bloom was on the trees, indicating that the cultural practice had been successful. Where tangerines or oranges have been interplanted in lemon groves, the verdelli practice is complicated, since it also forces a bloom on these trees, which produce a fruit of little commercial value, and this probably reduces the orange and tangerine crop set at the regular bloom. The interplanting of orange and tangerine varieties is being done as a "hedge" against destruction of the lemon trees by mal secco.

The following translation of excerpts from Annali gives an excellent account of the verdelli practice.

The Italians refer to a fruit produced by the regular bloom as a "lemon;" however, the fruit produced by the verdelli bloom is called a "verdello." 2/

The Forcing of the Lemon for the Production Verdelli 3/

The practice for obtaining verdelli, the so-called forcing of the lemon, begins during the last 10 days of June (earlier in the case of old citrus groves and those with little exposure to the sun, later for young groves and those which get a great deal of sunshine) when irrigation is suspended for 30 or 40 days, i.e., until about the end of July or the first of August.

The suspension of irrigation causes withering of the leaves and thus weakens the functions of transpiration and photosynthesis. The trees enter into a latent state of life, and gradual weakening which, contained within proper limits, predisposes to a rich and copious flowering.

If the drying goes beyond the proper limits, the life and vigor of the trees are endangered. Partial defoliation occurs, with dropping of the lemons and little, if any, flowering. The yield is therefore low, with the crop consisting solely of out-of-season lemons (bastardi). The trees also tend to produce wood branches (taddera).

2/ Verdello is the singular, verdelli, more commonly used, the plural.
3/ Annali della R. Stazione Sperimentale di Frutticoltura e di Agrumicoltura di Acireale, New Series v. II, Acireale, 1935. Translated from the Italian by May Coult.

In the case of inadequate drying or insufficient weakening, the trees tend to put forth woody branches, with few, if any, flowers, and produce jancuzzi and verdelli maiolini in place of the desired verdelli.

The skillful citrus grower must know how to achieve the right degree of drying at the right time by advancing or delaying the beginning or end of the drying, in accord with the progress of the season, the greater or less depth and permeability of the soil, the lay and exposure of the land itself, the age of the trees, and the distance between them.

The majority of the citrus growers are real masters of the operation of producing verdelli, and they know how to read in the general aspect of the trees and in the state of withering of the leaves the exact point of the drying. Only occasionally do they resort to the common means of examination of the leaves, which have become weak and as if in an advanced state of shriveling lengthwise of the blade, taking some in the early morning hours, or near the end of the day, never in the hotter hours, pressing them in the hand, and observing that they do not break in pieces but remain only doubled back.

About the last of July or the first days of August, according to region, weather, greater or less depth, and permeability of the soil, irrigation is renewed.

The first four irrigations are made 3 or 4 days apart, and care is taken to apply to the individual trees in the first irrigations, a quantity of water corresponding to less than half of that used in the ordinary irrigations; to increase this quantity in the three successive irrigations, until half the normal amount of water for an irrigation is applied; and then to proceed progressively to the ordinary irrigations in regular turn

Cases are found where some of the trees, because of special conditions of the soil in which they grow, show the need of irrigation when the majority must still remain in the drying period. Not to irrigate them is not desirable; for this purpose a little water is administered with barrels or quartare (quarter barrels) every four days. And in case the majority of the trees have reached the right point, no account is taken of every tree, or of only a few trees, considering that the damage done by limiting the production of these few trees is very small.

The renewal of irrigation, commonly called abbivirata, is preceded by the application of chemical fertilizers, ordinarily composed of:

> 1 kg. 4/ ammonium sulphate, 1 kg. mineral superphosphate (P_2O_5), and 0.300 kg potassium sulphate; or 1 to 1.5 kg. superphosphate (P_2O_5), and 0.8 to 1 kg. ammonium sulphate; or 1 to 1.5 kg. superphosphate (P_2O_5), 0.4 to 0.5 ammonium sulphate, and 0.5 to 0.7 kg. nitrate of sodium or calcium.

The nitrate is generally applied in two applications after the first irrigations.

4/ 1 kilogram = 2.2 pounds.

There are those who substitute for the ammonium sulphate either nitrate of calcium or sodium in applications of 1.2 to 2.4 kg., or ammonium nitrate in applications of 1.2 to 2.4 kg. or ammonium nitrate in applications of 0.500 to 0.700, kg. in two or three applications, always making the first one before the first irrigation.

The use of potassium fertilizers is not general, and those who use them make application in a reduced quantity which varies from 300 to 600 grams.

There are those who make use of only nitrogenous fertilizers in large quantities, but the majority operate with exact criterion in the matter of fertilizers.

The lemon tree also receives the organic manuring indicated for citrus groves in general.

Following the practices indicated, the trees recover vigor, the leaves again become turgent and regain their natural color, the little lemons existing on the tree, which have had their growth suddenly arrested, start growing again, new shoots appear, and everything encourages the best hopes of the citrus grower.

On the appearance of the flowers, irrigation is suspended to avoid dropping, and renewed after nearly all of the blooms have set fruit.

In many districts forcing is done annually, and in this case the total crop of lemons is, within limits, the crop of verdelli; the initial period of irrigation is set up to April - May, and that of the dry stage to the first of June.

Cases of periodical biennial, and triennial forcing exist, where the citrus grove is divided into two or three sections, and one is treated every year. The biennial system is more generally adopted.

The regular course of the interesting practice can be upset, even to the point of eliminating the production of the verdelli, by rains during drying period. Luckily, however, these are rare.

Not all soils are suited to forcing. In deep, cool, clayey soils, forcing becomes very difficult, and the same is true of new plantings, and means of avoiding this difficulty are being studied.

The practice of forcing lemons is judged irrational by many, and dangerous to the life of the lemon grove. It cannot be denied that forcing in itself weakens the trees and may shorten their life; but this practice is being followed with care and perfection, and there are lemon groves which show no injury after being forced for more than 40 years.

The Experiment Station at Acireale has studied the effect verdelli practice has on the percentage of fruit produced by each lemon bloom and the result of this study is shown below:

	Percent of harvest
Forced lemons (verdelli practice):	
1st crop (December)	5
2nd crop (February)	20
3rd crop (April)	30
4th crop (June-July)	45
Lemons not forced:	
1st crop (November)	25
2nd crop (January)	30
3rd crop (March)	44
Remaining on tree	1

The verdelli practice probably makes trees more susceptible to mal secco since a growth period with its tender leaves occurs during the late fall when the mal secco fungus spores are activated by the first fall rains.

Pest Control

A number of scales, citrus pests, and other insects are found in the citrus areas. 5/ Among these is the Mediterranean fruit fly (Ceratitis capitata), which damages tangerines and oranges each year. The lemon is not attacked, and some orange varieties, such as the Ovale and Belladonna, are somewhat resistant, but the "off-bloom" fruit of these varieties is susceptible to attack.

Pests are controlled both by spraying and by fumigation. In 1949 fumigation was conducted by a semi-government organization which obtains some assistance from ECA funds. Each grove is fumigated every 3 years at a cost to the grower of approximately 200 lire (35 cents) per tree.

5/ The following species of scales and citrus pests were found in Sicily in 1935: Aspidiotus hederae Vallot (circular scale), Chrysomphalus dictyospermi Morg (red scale), Ceroplastes sinensis del Guercio (yellow scale) Coccus hesperidum L. (turtle-back scale) Saissetia oleae Bern (black scale), Pseudococcus citri Risso (mealy bugs), Icerya purchasi Maskell (cottony cushion scale), Parlatoria pergandii Comstock (chaff scale), Parlatoria ziziphi Lucas, and Lepidosophes citricola Pack (purple scale). Other insects present in citrus areas at that time were: Toxoptera aurantii Boyer, Prays citri Mill., Heliothrips haemorrhoidalis Bouche, Tropinota hirta Poda, Oxythyrea funesta Poda, Phyllognathus silenus Fab., Tapinoma nigerrimum Nyl., Ceratitis capitata Wied. (Mediterranean fruit fly), and Tetranychus telarius L. (Annali, v. II, Acireale, 1935, pp. 91-95).

Spraying with a 2 percent white oil mixture is customary twice a year, usually about August and January, although the frequency of application varies according to the seriousness of the infestation. The annual cost of spraying, including labor and material is considered to be approximately 100 lire (17cents) per tree per year.

In every grove visited, spraying was done by hand-pumped machines, some similar to the 3-gallon pressure sprayers commonly used in gardens here. Other hand machines were mounted on wheels and pulled through the orchards.

All spraying is done from the ground, and extensions are placed on the spray hose in order to spray the upper limbs of tall trees. When spraying is practiced as a pest control measure, approximately 4 to 5 quarts of spray material are applied to each tree. This rather light dosage is possible for two reasons: first, because of the small size of the trees, particularly if there is an interplanting of tangerines which are scarcely more than 6 to 7 feet in height; and, second, because of the manner in which these sprays are applied to the trees. Since there is not much pressure and only poor agitation of the mixture, the sprays are applied as a fine mist. Under this method of application there is little waste of material, but it appears to be very difficult to obtain complete coverage of the tree surfaces.

In 1949 the Argentine ant was a very serious pest in the vicinity of Palermo. It was being controlled under a program operated by the Italian Ministry of Agriculture and administered locally by the "Ispettorato Provinciale Agraria." Under this program the citrus area has been divided into districts, and each is being treated in turn, a work which will require several years. In each district being treated every grove was sprayed with "clortox." This chemical was applied by means of a hand-pumped sprayer to the tree trunk to a height of about 2 feet and on the entire ground surface under the tree. This program receives some ECA funds to carry out this work.

Spraying and fumigating are often used as alternate methods of control. A grove may be sprayed for 2 years and fumigated the third year. The hydrocyanic material is brought to the grove in large glass containers with a capacity of about 8 gallons. These containers and the fumigating tents are carried from grove to grove by two-wheeled carts, and, on evenings when fumigation is to be carried on, carts can be seen rocking down the roads to the orchards. A fumigation crew commonly consists of seven men, who usually each earn approximately 700 lire ($1.22) per day. These men work approximately 3 to 4 months a year at this occupation, 2½ to 3 months in the summer and 1 month in the winter.

In orchards visited, scale pests seemed to be under quite satisfactory control. It was noticed, however, that the bergamot orchards in the vicinity of Reggio are more poorly cared for as regards pest control than are the citrus areas in Sicily.

Disease Control

Since the Italian citrus industry is an old culture, and many of the trees are 75 years of age or more, the problem of disease control is a serious one in most orchards. A discussion of Italian citrus diseases is found in Annali, published by the Experiment Station at Acireale in 1935, and translated excerpts from their comment on the more important diseases are given below, together with observations made in the field.

According to Annali, the most important citrus diseases in Italy are root roto gummosis, bacterial diseases, and mal secco.

Root rot. Citrus seedbeds are injured by rot caused by Rhizoctonia and other fungi. Excessive irrigation, poor drainage, inadequate soil aeration, density of seeding, excessive shade, hot humid air, and an excess of organic matter favor the development of the disease. When the disease appears, it is necessary to suspend irrigation, remove the dead and dying plants, and sprinkle 2 inches of sand between the plants. 6/

What appeared to be oak root fungus (Armillaria root rot) was observed in the vicinity of Palermo. Growers stated that infected trees are removed from the orchard, a large hole being dug when the roots are removed. Quick lime is placed in this hole, and covered with approximately 8 inches of soil which is allowed to disintegrate over a period of nearly a year. Before a new tree is planted in a diseased area, the remaining lime is removed and top soil is placed in the hole. This method of control seems effective, since infection did not appear to be widespread.

Gummosis (Phytophthora). Gummosis manifests itself by cracks in the bark and the exudation of a gummy substance at the points where the bark is cracked. It may attack the base of the trunk of the tree, spreading in the soil to the zone of the principal roots and up the trunk to a certain height (root collar gummosis), or it may attack the trunk and branches. The various species of the genus Citrus are not equally susceptible to gummosis. The bitter orange offers the greatest resistance, followed by Citrus triptera, shaddock, rough lemon, tangerine, sweet orange, lemon, and citron. 6/

Since the disease develops most rapidly in moist soils, it presents a real problem in Italian citrus orchards, particularly in closely planted orchards in Sicily where it is impossible to keep irrigation water away from the trunks of the trees. The disease is especially prevalent in areas of heavy soil, which retain moisture, and during winters of extended and heavy rains.

Preventive practices include high budding, about 2 feet from the ground, and the use of sour rootstock exclusively. Treatment of infected trees usually consists of trunk surgery by which the diseased areas of bark are cut away and long, narrow vertical cuts are made in the bark of diseased

6/ Translated from Annali.

areas in order to drain away excess gumming. When disinfectants are used, iron sulphate is applied to the wound. This treatment seems to be successful in prolonging the life of diseased trees.

Mal secco. 7/ The pernicious fungus disease, mal secco (Deuterophoma tracheiphila Petri), is continuing its spread in Sicily, and is to be found in all lemon producing areas, including Palermo, Barcellona, Messina, Catania, and Siracusa. To control the disease, growers immediately prune the infected areas of the tree. This fungus usually enters the tree through the leaves. Spores fall on the leaf surface, penetrating the leaf, and the fungus then grows down into the woody framework of the tree. As diseased areas are removed, they are immediately burned, since the dry, infected leaves will carry the fungus and release spores which will spread the infection. If diseased leaves are cultivated into the ground, the disease may be transmitted to the tree through the roots. This is the most dangerous method of infecting trees. When diseased limbs are removed, the bark is peeled away, exposing the part of the fungus which is visible as a yellow stain on the surface of the wood. By exposing the diseased area to the air the progress of the disease is retarded, and the life of the tree is prolonged.

This disease is most active in Messina, and many orchards of the comune variety of lemon have been completely destroyed, or so many trees have been removed that the orchards can no longer be considered as commercial.

A resistant variety of lemon has been developed and is called Monachello. This is in two types. One has a rather broad, crinkled leaf with tight foliage and produces a rather odd-shaped lemon on which the blossom end is much larger. The other variety has a longer leaf and produces a lemon of more conventional shape. There is an extensive program of replacing diseased trees with these resistant varieties in Messina. That this variety is resistant is indicated by its success in diseased orchards. The variety produces a different type of lemon from the comune, one that does not produce as much or as high quality essential oil. Also, its production of fruit is somewhat lower per tree. The Monachello also has entirely different growing habits from the old varieties, which were very upright growing trees, the upper limbs of which were usually of an oval shape. The framework limbs of the Monachello were observed to be nearly round, and the shape of the tree is lower and spreading, very similar to the growing characteristics of Washington navel orange trees. The Monachello seems to have an advantage, however, according to reports by growers, in that it produces more summer lemons, or verdelli. The area of Roccalumera, which has long been the district famous for its Verdelli (lemons raised by the forced culture), is being planted largely to Monachello trees.

7/ For a detailed account of this disease see Mal Secco, Foreign Agriculture Circular FCF-6-50, Office of Foreign Agricultural Relations, U.S. Department of Agriculture, Washington, July 28, 1950.

In orchards destroyed by mal secco, growers are also replacing lemon trees with orange or tangerine trees. However, some of the new lemon plantings in the Messina area are mixed with orange and tangerine, indicating that the growers desire to have a hedge against the possibility that the Monachello may not prove as resistant as is now thought.

The Experiment Station at Acireale is continuing to experiment with seedling trees of resistant qualities. Aside from the growing and planting of resistant varieties, there is at present no known control for the spread of the disease other than the surgical removal of the diseased areas. By this practice the bearing surface of the grove is progressively destroyed.

The fruit picked from diseased trees may also be infected with the fungus according to informed sources in Italy, and usually may be identified, since they color more readily, and the button is usually shed in the picking process. Diseased fruit may be identified by a slight orange pigmentation of the area under the stem button. If the fruit is cut it will be noted that this orange pigment is to be found in the core of the fruit and at the blossom end. 8/

A minor effort to control the spread of mal secco is to practice "sandwich" budding, whereby a sweet variety such as orange or tangerine is budded to the sour stock, leaving a sandwich of from 6 to 12 inches between the lemon top and the sour root. This is intended to save the root in cases where the top becomes infected and it may also give trees a resistance to the disease.

The effect of mal secco on Sicily to date has been to destroy large areas planted to the comune lemon variety, which is highly susceptible. In most favorable lemon districts, such as the Messina area, destroyed acreage has not been entirely replaced by resistant varieties; however, enough former lemon orchards are being replanted with orange and tangerine trees to result in increased production of these fruits in the next 5 years. The cost of removing diseased parts of trees has increased the production cost to growers and has reduced the production of fruit per hectare in many groves. Since this disease is continuing to spread and because of its pernicious nature, it would seem to be a wise action if the United States lemon industry were to obtain seeds of the developed resistant varieties for planting in Experiment Stations so that their growing and producing characteristics under United States climatic and cultural conditions could be studied.

Bacterial diseases. Bacterial disease causes a drying of the shoots on the adult trees, also of 1- or 2-year branches, but never the withering of large branches. The bacteria which causes this infection is Phytomonas citriputeale C. O. Smith. Bacterial diseases can also affect the trees in the nursery, especially when they are subject to injurious action by the wind, and can also affect the fruits. 9/

8/ Fruits in this condition were seen. Cultures of these fruits would be necessary to prove the presence of the fungus.
9/ Translated from Annali.

Experiment Station at Acireale

The experiment station in Acireale near Catania is set up to carry on work with problems of culture, variety, and disease control. The station has a large laboratory building with seemingly well-equipped work rooms. A portion of the building is devoted to the production of "crypt" (Lady beetle--cryptoloemus montrouzieri) to be liberated in the orchard for the biological control of the mealy bug. This is said to be the only place in Italy where crypt is raised. The quantity released each year is probably small, since production seems to be on a laboratory scale.

The laboratory building has a very fine exhibit of the tools used for cultivating vineyards at Pompeii and a large collection of "modern" cultural tools used in vineyards and citrus plantings today. It was interesting to compare the tools and to note how little the shape or design of the major cultivating hoe has changed.

While the experiment station is concerned primarily with citrus, it also conducts studies on deciduous fruits, olives, and other tree and vine crops.

In the experimental gardens, large concrete tubs approximately 6 feet square are filled with soil from the various important citrus districts, and a lemon tree is planted in each tub, and experimentation is carried on with various types of fertilizing products. It would probably be difficult to interpret the results obtained by this method of experimentation as it relates to actual field practice in the orchard. So far as was learned, there are no experimental orchard plantings devoted to experimentation with fertilizer, irrigation, or other cultural practices.

Numbers of young lemon trees are being raised at the station with the hope of developing new mal secco resistant varieties. The present seemingly resistant variety, the Monachello, has several undesirable characteristics: it does not bear as heavily as the comune lemon, and the peel is not so suitable for the extraction of essential oils. Also, the broad-leaved type of Monachello produces an odd-shaped lemon which does not command as high a price as the more normal-shaped fruit.

The studies are primarily confined to scientific investigation. The station has no publications of the type issued by the United States Extension Service to assist growers.

ITALIAN CITRUS VARIETIES

The Italian citrus industry is based on citrus varieties which are, on the whole, foreign to the United States industry. The source of most of this information on varieties is Annali. 1/ Although published in 1935, it is the most complete and latest Italian publication on the subject known to the author. Little change in varieties has taken place in the intervening years, except for the growing importance of the Monachello lemon due to the continued destruction of groves by mal secco.

Orange Varieties

There is no commercial production in Italy of any of the orange varieties which are grown commercially in the United States. The European market regards the Italian blood oranges as the finest they receive. The outstanding blood oranges are the Tarocco and the Sanguinello. The Sanguinello, in particular is unusual; the red pigment is in the flesh of the fruit, and its juice is wine red, similar in color to port wine. The most important non blood variety is the Ovale, which might be an interesting variety for processing purposes.

The following orange varieties are listed in Annali as grown in Sicily in 1935: 2/

Blond (nonblood) varieties	Blood varieties
***Ovale or Calabrese	***Tarocco
**Belladonna	**Sanguinello comune or Sanguignu a pignu
*Biondo comune or Nostrale liscio	*Sanguigno semplice
*Biondo riccio	*Sanguigno doppio
Maltese, Dolce, or Vainiglia	*Doppio sanguigno Signorelli
Arancio barile	*Ovaletto sanguigno
Biondi di spina or di ariddu	*Vaccaro
	*Moro or Selezionato or Belladonna sanguigno
	*Sanguigno zuccherino
	*Sanguigni di spina or di ariddu

1/ Annali della R. Stazione Sperimentale di Frutticoltura e di Agrumicoltura di Acireale, New Series v. II, Acireale, 1935.

2/ ***A variety of the first order "aristocrate," of major importance in 1935; **Ordinary commercial variety; *Minor variety cultivated to a limited extent.

The season of maturity of Italian oranges and tangerines is shown below:

Blond (nonblood) varieties

Biondo di spina or di ariddu	Second 10 days of November
Biondo comune	Last 10 days of November, December (Picking can be protracted until March-April)
Biondo riccio	Last 10 days of November, December (Picking can be protracted until May)
Belladonna	December on (The fruits can be left on the tree until March-April)
Washington Navel	December on
Maltese or Vainiglia	December on
Arancio barile	February-March
Ovale or Calabrese	March-May

Blood varieties

Moro	Last half of November on
Ovaletto sanguigno	Second 10 days of December on
Tarocco	Second or last 10 days of December (After January the fruits do not keep well on the tree)
Sanguigno zuccherino	December-March
Doppio sanguigno Signorelli	End of December-April
Sanguigno semplice	January-March
Sanguinello comune or Sanguignu a pignu	January-March
Sanguigno doppio	January-March
Sanguinello moscato	January-May
Vaccaro	January-May

Tangerines and some hybrids

Satsuma	October-November
Clementine	November-December
Mandarin	December-January
King	February-March
Dancy tangerine	February-March
Tangelo	February-March

Lemon Varieties

The varieties of lemons raised in Italy are also different than United States commercial fruit, and the varieties cultivated in Sicily in 1935 are listed below: 3/

***Interdonato, Limone fino, Limone speciale or liscione
***Ruvittaru or Limone Femminello ovale comune
***Limone Femminello sfusato or di Favazzina or di Siracusa

3/ ***A variety of the first order "aristocrate," of major importance in 1935; **Ordinary commercial variety; *Minor variety.

**Limone Cucuzzaru or Arancino or'Mapalluggiatu or Pappalardaru
**Limone Lunario
*Limone Moscatello or Russiddaro or Mussu di Pupa or Monachello
*Limone di spina Corpace
*Limone Francescano

As important as varieties in the Italian lemon industry is the character of the fruit produced by each bloom. The maturity and period of harvest of Italian oranges is related to orange varieties; however, this is not true of Italian lemons, as is indicated by the calendar of lemon harvest.

For lemons, the fruit of each season is known by the name of the bloom which produced it, not by the name of the variety. The harvest seasons for lemons are as follows:

From the end of September to the end of November: Primofiore and Interdonato
From December to June: Winter lemons, or just "lemons"
In April-May; Jancuzzi and ricioppi
In May-June: Verdelli maiolini
June-August: Verdelli
September: Verdelli and out-of-season lemons

The harvest calendar refers to lemon blooms, not varieties. Each variety of lemon described may produce some fruit for each of these indicated harvest seasons.

Commercially, Italian lemons are known by the bloom which produced the fruit rather than the lemon variety. The reason for this is the difference in the shape and quality of fruit which each bloom produces. The differences in fruits of the same variety produced by different blooms is greater than the differences between varieties in the same bloom.

Descriptions of Lemon and Orange Varieties

Varieties and blooms are of such importance to an understanding of the Italian citrus industry that descriptions of the important commercial varieties are given below.

Varieties of Lemon Cultivated in Sicily 4/

I. Interdonato, Limone fino, Limone speciale or liscione

The tree is vigorous; the branches are robust, having few subbranches; the tree is ordinarily thornless; and the tips of the shoots are violet-colored.

The leaves are elliptic, and undulating on the edges; the margin is crenate; rachis raised above the two halves of the leaf; the

4/ From Annali. Translated from the Italian by May Coult.

petiole is slender, short, yellow, and not margined.

The fruit is large, elongated, cylindrical; the navel is conical acuminate, almost always as if emerging above a well-defined plane; the peel is smooth, shining, very fine-grained, and thin; the glands are numerous, neither buried nor raised; sections, 8 or 9 in number; seeds are not numerous; the rag is elongated, tightly fitting, greenish-yellow in color, juicy; the juice is abundantly acid, perfumed, and slightly bitter; the calyx is of medium dimensions, raised, five-divided, and of a light green color.

II. Femminello comune or ruvittaru or ovale comune

The fruit is oblong, of medium dimensions, lemon-yellow color, the navel is not very much developed and is obtuse; the calyx is of medium dimensions, the sepals number 4 to 5 and are obtuse; the peel is of medium thickness; the essential oil glands are medium large and depressed; the pulp is fine and is of pale greenish-yellow color; the rag is small, acuminate and elongated; the juice is abundant, of light color, and is rich in acid, and has an excellent perfume; the seeds are not very numerous, and the majority are aborted.

The tree is of medium vigor, almost without thorns. It is the type most widely disseminated and appreciated by the citrus growers because of its constant and abundant production, because it is very well adapted to forcing, and because of the resistance of the fruit to shipping damage.

III. Limone Femminello sfusato or di Favazzina or di Siracusa

The tree is vigorous; the shoots are violet in color; the leaves are large, oblong, acuminate, unequally crenate; the petiole is long and slightly marginate.

The fruit is elongated, with the navel well developed and acute in the lemon and less so in the verdello; 5/ the stem area is raised; the grain is fine or medium; the peel is of medium thickness; the glands slightly raised; the sections are compact and juicy; the juice is abundantly acid and perfumed; and the seeds are often numerous.

This is a productive variety, well adapted to forcing, and is widespread in the provinces of Messina and Siracusa. It is being supplanted, however, by the Femminello comune and by the Cucuzzaru, because the fruit, although elegant in form, gains little acceptance by the exporters because of the difficulty which it frequently offers in regulation packing.

IV. Limone cucuzzaru or Arancino or 'Npalluggiatu or Pappalardaru

The fruit is globose, tending toward a spherical form, especially the verdello, average dimensions; navel little pronounced; peel rather thick; essential oil glands large, some raised and other depressed; the rag is tightly fitting; the juice is abundant, acid, and perfumed; and the seeds are numerous.

5/ Fruit produced by the verdello bloom, the singular of verdelli.

The tree is vigorous, ordinarily with branches at very short internodes, and spineless; the leaves are small.

It is a type appreciated by the citrus growers for its hardiness, constant, high, uniform production, and for its high predisposition to forcing, and because of the early ripening of the first flowering (primo flore).

In the production of verdelli it always yields beautiful clusters, such as are not found in other varieties.

V. Limone Lunario or Palermitano

The leaves are medium or small, elliptical, thick, slightly crenate, acute, a brilliant dark green in color; the petiole is long, ordinarily contorted.

The fruit is medium oval or globose or claviform, smooth, and often pointed toward the base; the base is sometimes furrowed longitudinally; the navel is acute, little developed; the peel is thin, strongly adhering to the sections; the calyx is small; the glands are large; the sections 11 or 12 in number; the pulp is fine, greenish in color; the rag is elongated and compact; the juice is not very abundant, but it is perfumed; the seeds are numerous, oval, acuminate. The fruit has little essential oil content.

It is a continuous-flowering variety, very productive and extremely sensitive to forcing. The trees subjected to forcing produce abundantly, but the fruits ordinarily remain small, and the normal crop suffers in quantity and quality.

This variety is customarily cultivated in the province of Palermo, and somewhat in the vicinity of Catania, where it is known under the name of "innesto palermitano" (Palermo graft). In the province of Palermo it is found in specialized culture in the zones of Pallavicino and Partanna-Mondello, and sporadically everywhere.

VI. Limone Moscatello or Russiddaro or Mussu di Pupa or Monachello

The fruit is moderately fusiform, with the navel almost rudimentary, flat, more developed in the verdello than in the lemon, 6/ but always less developed than in the other types; the grain is fine; the peel thin; the essential oil glands are large and slightly sunken; the rag is thin, and long, and quite tightly fitting; ordinarily it is without seeds or has a few small or aborted seeds; the juice is abundantly rich in acid and is highly perfumed.

The branches are slender; the leaves small, danceolate, and of an intense green color. The small leaves on the shoots are strongly tinted with violet.

The verdelli remain small for a certain period and then grow rapidly. At the beginning of their development they are of a "nutmeg" color, and

6/ "Lemon" is used as a bloom name for fruit ripening from December to June.

ribbed, but these ribs disappear later. They "scald" easily if left on the tree after May.

This type produced few lemons and many verdelli if subjected to forcing, but is not widely grown because the fruits do not stand shipping well.

The Moscatello has subtypes, one of which is known by the name of Monachello, which has elongated fruit with a very fine grain, smooth skin, shining and appearing to be covered with a waxy patina, a pronounced navel, and no seeds. This type is adapted to forcing.

The Monachello appears to have a certain resistance to mal secco. This was first pointed out by Avv. Ernesto Gugliotta and the Interdonato Brothers of Nizza Sicilia. The Experiment Station at Acireale which is carrying out experiments to find a type of lemon resistant to the mal secco, has taken the Monchello under examination. 7/

VII. Limone di spina "Corpaci"

This is an interesting type of lemon, cultivated in the citrus grove of Cav. Corpaci in the Simeni region (Siracusa), to which the farmers of the region have given no specific name. It is conspicuous for ripening earlier than the other varieties, for its uniformity of production, high yield, and beauty of fruit. The tree is vigorous, with thorny branches. The leaves are large, oblanceolate with acuminate tip, crenate, smooth, slightly undulating on the margin; the petiole is short, light green in color, and slightly marginate.

The fruit is bimammillate and of average size, fusiform; the navel is conical, acute, not greatly developed; the grain is fine; the skin is thin, smooth, and shining; the sections number 8 to 9, and are compact and juicy; the peduncle is large; the calyx is large; and there are not many seeds.

7/ The Monachello fruit seen in Sicily in the September 1949 and in United States fruit markets in 1950 was a less acid lemon than the widely grown comune and had less oil in the peel. The fruit of the Monachello has a distinct form, the stem end being shaped more like the stem end of an orange than that of a lemon. The navel at the blossom end is not so pronounced, and the skin texture tends to be finer than the comune.

The limbs of the comune lemon tree are oval, the frame-work limbs sometimes being almost pointed on their upper edge. The limbs grow upright from the tree trunk. The limbs of the Monachello lemon tree are nearly round and the tree grows in a spreading shape like a navel orange tree. The difference in the shape of the tree limbs of these two varieties compared with the growing characteristics of the trees suggests that there may be a correlation between limb shape and tree shape in citrus.

The orange-like shape of the stem end of Monachello lemons, together with the lower acidity and the orange-like shape of the tree limbs, lead one to suspect that this variety is in some way related to the sweet orange, and because of this attains its mal secco resistant qualities.

VIII. Limone Francesano

This variety is grown in the Palermo region, but is not widely cultivated there. It is held in very low esteem, because the fruit possesses but little resistance to transportation, and it is readily susceptible to the specific agents which cause rust (nasca di ferro). It also has a pronounced tendency to run to leaves, and has a low content of acid and essence in its juice.

Varieties of Orange Cultivated in Sicily 8/

I Ovale or Calabrese (a nonblood orange)

Among the varieties belonging to the "blond" group, this is the most important, and seems destined to remain the only one under commercial cultivation, since the others are giving way more and more to the blood varieties which are in greater demand.

The fruit is oval in form, of rather more than average size. The epicarp is of a light yellow color and fine or medium grain. The pericarp strongly adheres to the rest of the fruit, is of medium thickness or less, and is more marked in the part near the peduncle. The endocarp has compact, tightly fitting sections strongly adherent to the pericarp, an agreeable flavor when full ripe, and very few seeds, frequently none.

It is the latest variety of orange. The fruit matures between the end of winter and spring and can conveniently remain on the tree nearly all spring. The fruit has the singular characteristic of being able to remain on the tree from one year to another. After full maturity, it turns green again, and remains green during the entire summer and part of the winter; it then changes to the characteristic normal yellow. When it turns green again, the endocarp remains as if empty of the major part of the juice, and becomes juicy again with the return of the normal yellow color.

It is lamented often enough that the Ovale oranges bears but little fruit, but when it is cultivated in deep, fertile, fresh, and conveniently irrigable soils, the yield is neither insufficient nor undependable.

The Ovale orange is widely grown in the fertile soils of the land surrounding Lentini, Carlentini, Francofonte, on the plains of Paterno, Centuripe, and Salso, and in the wide valley of Sinagra, and yields a rather abundant crop.

II. Belladonna (a nonblood orange)

After the Ovale, this is one of the most highly esteemed "blond" varieties.

The fruit resembles that of the Ovale variety, but is of a little larger size and with an epicarp of a more marked yellow color; it has a medium or coarse grain, the pericarp is of medium or great thickness, especially near the peduncle; the endocarp has well-developed sections rather adherent to each other and to the rest of the fruit, an agreeable flavor, and few if any seeds.

8/ Translated from Annali by May Coult.

The fruits are heavy and can stand long shipments. Before the war they were shipped to Russia, like those of the Ovale variety.

Ripening takes place in December, and the fruits, which are very stubbornly attached to the peduncle, can easily be kept on the tree until March or April. It is generally preferred, however, to pick the crop in good season, i.e., before the common Sanguigni or Sanguinelli invade the consuming markets, where they receive the preference.

III. Biondo comune or Nostrale liscio (A nonblood orange)

This is one of the oldest cultivated varieties. In old citrus groves it may still constitute the bulk of the production.

The fruit is spherical with a depression at the peduncle; it is of medium or even superior size; the epicarp is golden yellow with a fine or medium grain; the pericarp is medium-to-thick; the endocarp, with rather fragile sections, is rich in juice and has a sweet agreeable flavor at advanced maturity; it has abundant seeds.

The harvest of this variety is begun very early (November-December), especially in certain zones, such as the Francavilla area in the province of Messina, and is then continued until March and April.

The fruits are medium-heavy and stand shipping well.

The tree attains large dimensions and bears abundantly (an average of 400 fruits per tree). It is rather hardy and has no special cultural requirements.

Although it has merit, this variety is being excluded from the new plantings, and seems destined to become extinct, preference being given to the Sanguigne varieties almost everywhere in Sicily.

IV. Biondo riccio (Hedgehog blood-a-nonblood orange)

This variety is also among the oldest in cultivation and is found in citrus groves that have long been planted.

The fruit is roundish, of larger than average size, with an epicarp of a dark yellow color and coarse grain, rough, hence the name of biondo riccio; the pericarp is very thick; the endocarp has sections of average consistency; the flavor is agreeable when fully ripe; seeds are abundant and well developed.

The Biondo riccio orange is of average weight and somewhat resistant to transportation. It formerly made up the larger part of the export trade with the United States.

Harvest time for this variety is almost identical with that for the Biondo comune, but is protracted up to the month of May.

The tree attains average size and bears abundantly (an average of 400 fruits per tree).

This variety is also hardy and has no special cultural requirements.

V. Maltese, Dolce, or Vainiglia (A nonblood orange)

This variety, known for a long time, has never been important commercially, because the fruits are not generally accepted.

The fruit is roundish, but sometimes depressed like a Doppio Sanguigno. It is of average or even inferior size, with an epicarp of dark yellow color and average grain; the pericarp is of average or great thickness; the endocarp with perceptibly developed sections is rich in juice of a honey sweet not very agreeable flavor; the seeds are abundant. The fruits which are not well ripened have a slightly bitter flavor. Harvest is from December on.

The tree attains average dimensions and it produces rather abundantly.

This variety will always be cultivated spordically.

VI. Arancio barile (A nonblood orange)

The fruit is of an elongated oval form with a pronounced peduncular lobe and terminating almost in a point. Its size is less than average. The pericarp is of an intense yellow color and average grain; the pericup is of medium thickness; the endocarp, with sections rather compact, has an agreeable flavor, and few seeds.

Harvest is from February to March.

The tree attains average dimensions and has no special requirements, but it is a poor producer.

This variety is among those destined to remain cultivated only sporadically.

VII. Biondo di spina or di "ariddu" (A nonblood orange)

The thorny blond oranges do not represent a variety, but a group of varieties which, since they all come from seed, have some common characteristics, among which are hardness and early ripening, the presence of thorns, majestic bearing of the tree, and high yield.

The fruits are usually roundish, of medium size. The epicarp is golden yellow and has a very fine polished grain; the pericarp is thin, the endocarp, with sections of average compactness, is rich in juice, and has an agreeable flavor, and numerous seeds.

Because of the presence of the thorns, the fruits often suffer serious damage from the wind, especially when harvesting is delayed beyond the second 10 days in November.

The thorny oranges, in addition to being early, are of rapid growth.

The tree, as already stated, reaches great dimensions and is very productive (it sometimes yeilds as many as 2,000 fruits, but the average production is 600). It is hardy, and has no special requirements other than a greater need for nutritive materials than other oranges because of its growth and yields.

This group of varieties also cannot be popular as a commercial crop.

VIII. Tarocco (A blood orange)

This variety owes its name to the form of the fruit, which approaches that of a peg-top. Known only from the early years of the present century, it has spread for the last few decades. Its cradle was Piedegaggi di Carlentini in the province of Siracusa. Dinaro Gesualdo found it in a citrus grove in the Carbone area, whence it has spread into other regions in the same territory (Buonafede, Cassimino, Vicinori, etc.), and into many citrus areas in the provinces of Siracusa (Lentini, Francofonte, etc.), Catania (the Etna area and that around Caltagirone), and Messina (Francavilla di Sicilia). It can be said that there is no citrus territory today where the Tarocco has not been or is not being introduced.

IX. Sanguinello comune or "Sanguignu a pignu" (Sanguinello moscato e Sanguinello doppio moscato) (A blood orange)

The Sanguinello comune, together with the Sanguigno semplice and the Sanguigno doppio, constitutes the bulk of the total production of blood oranges.

It is cultivated extensively in the provinces of Siracusa and Catania.

The fruit is of medium size, of an oblong shape. The peduncular lobe is only slightly developed and has characteristic grooves; the epicarp has medium grain, and is a dark yellow color blended with red; the pericarp is of medium or greater thickness, medium toughness, and medium adherence to the remainder of the fruit; the endocarp with sections and of medium development is intensely colored with red at maturity; seeds are absent or nearly so; the flavor is agreeable; the fruit has moderate resistance to transportation damage.

Internal coloring precedes external, and is more intense.

The trees attain medium dimensions, and have a normal appearance and normal cultural requirements.

The yield is high and picking is done from January to March. After February the resistance of the fruit to attack at the peduncle diminishes, and the tendency to "earing" (Spigatura) increases.

An interesting subvariety of the Sanguinello comune is the Sanguinello moscato, which is common in the Etnean areas of Paterno, Adrano, and S. Maria di Licodia, where its production represents about two-thirds of the entire orange crop. In the trade, this subvariety is known by the name of "Paterno orange."

X. Sanguigno semplice (A blood orange)

Among the sanguigne (blood) varieties, this is perhaps the one which has been cultivated for the longest period of time, i.e., since the consuming markets have shown a preference for the blood varieties over the common blonds.

The fruit is of a size and weight similar to the Sanguinello comune, and is of a roundish form and slightly flattened at the stem end; the epicarp has a medium to coarse grain, and is of a yellow color noticeably tinted with red (more than the sanguinello); the pericarp is rather thick and with consistency and adherence to the rest of the fruit similar to the Sanguinello comune; the endocarp with the sections and the rag is of medium development and veined with red; the external coloration is more intense than the internal, and appears before the latter; it has a moderate number of seeds, and is generally well developed, and of agreeable flavor; it has moderate resistance to transportation damage.

XI. Sanguigno doppio (A blood orange)

The cultivation of the Sanguigno doppio, like that of the Sanguigno semplice, dates from far back, but its area of diffusion remains almost stationary. In the more recent plantings preference has been given and is still given to the varieties of greater value.

The fruit differs in form from the Sanguigno semplice. It is rather flattened at the ends; has a slight depression at the stem end, which is a considerable defect because it holds moisture readily; has rather coares grained pericarp noticeably dotted with red, with some rather dark violet stripes; and often has abundant seeds.

XII. Doppio sanguigno (A blood orange)

This variety, cultivated in some of the Etna areas (Paterno, S. Maria di Licodia, etc.), and also near Lentini, has not become wide spread because of its low productivity, although it has fruits of a truly select quality.

The fruit has the form of the Doppio sanguigno, but is of larger size, the epicarp is of a very intense red color (among the sanguigne varieties it is the one which has the epicarp most markedly colored) with some lighter blending; it has coarse grain veiled with bloom; the pericarp is quite tenacious, thick, and adhering to the rest; the endocarp is thin, with well-developed sections and a blood rag, juicy, with a very agreable flavor and an aroma of vanilla, with very few seeds or none at all. At the part opposite to the peduncle a navel or umbilical protuberance is often observed.

The fruits acquire the characteriatic external coloring and agreeable flavor in December, when the common bloods (sanguigni), Sanguinelli, and Doppi sanguigni are but little colored externally and have no pleasing flavor.

XIII. Ovaletto sanguigno (A blood orange)

This is a new variety, whose cultivation, like that of the Tarocco and the Moro, has spread in Sicily for only a few decades, particularly in the vicinity of Lentini Carlentini, and Augusta.

The fruit has a regular form reminiscent of a keg with circular sections and rounded ends; it is of medium or even superior size; epicarp is dark yellow, slightly tinted with red, similar to the pigmentation of the Tarocco; it has fine grain; the pericarp is slightly or medium thick, adhering well to the rest of the fruit; the endocarp has well developed sections and the rag is veined with red; it has few or no seeds and a quite agreeable flavor. The fruit stands shipping well.

The trees reach large dimensions, are rather hardy, and have no particular cultural requirements.

The fruits mature early, second among the blood oranges. The fruits are picked during and after the second 10 days in December. They present the phenomenon of polymorphism.

Yield is very high and rather constant. This variety is considered the most productive among the blood varieties. Average production per tree is from 500 to 600 fruits.

XIV. Vaccaro (A blood orange)

This variety originated in Adrano, and is cultivated only in some areas near Paterno. It is not well-known and is sometimes confused with the Moro or Selezionato variety, to which it really has no resemblance.

The trees have a characteristic growth of horizontal, pendulant, slender, weak branches, commonly called "affiminiddati."

The fruit is of average size, almost spherical, with a slight but characteristic furrow corresponding to the area of the stylar scar. The epicarp is fairly well-blended with red, fine-grained, and richly shining, polished by the "pesconoce," called in the vernacular "sbergio," for which reason the variety also takes the name of "Sanguigno sbergio." It has a thin pericarp, elastic, tenacious, and adhering well to the rest; the endocarp with sections developed, adhering well, and the rag shows some blood markings, and it has a very agreeable flavor, and contains only a few small seeds. The fruit hangs in the tree until the last of March.

XV. Moro or Selezionato (Belladonna sanguigno) (A blood orange)

This is a variety whose cultivation has spread during the past decade almost entirely in the area of Lentini and a little in area of Carlentini, where it continues to spread. At Lentini it is also known under the name of Selezionato, and it is sometimes given the name of Vaccaro in error.

The fruit of the Moro is rather squat and almost always above average size. The epicarp is of a dark yellow color which acquires red stains or streaks at advanced maturity, and the grain is medium fine; the pericarp is fairly thick and adhering to the rest; the endocarp has well-developed sections, with rag of a violet-red color reminiscent of the "sorosi" of Morus nigra L. (black mulberry); the seeds are absent or nearly so. It has a rather agreeable flavor which deteriorates until it becomes disagreeable with advanced maturity or after a long period of keeping.

The rag colors very early, even before the epicarp turns yellow, and this constitutes the principal means of identifying the variety.

The fruits stand shipping well.

The variety is very early, and is the first among the bloods to appear on the markets; it is considered ripe and is picked from the second half of November on. It ripens with the first Moro oranges, and sometimes accompanies only the common blonds and the thorny blonds in the markets.

XVI. Sanguigno zuccherino (A blood orange)

It is found cultivated sporadically in the old citrus groves of Grammichele, and here and there in those of Mineo and Palagonia.

The fruit enjoys the favor of the local consumers because of the very agreeable flavor of the pulp, but it is not liked by the great markets. It is roundish, of less than average size. The epicarp is yellow, with a slight blending of rose, and fine-grained; the pericarp is rather thin, of little tenacity, and subject to being easily lacerated at advanced maturity; the endocarp has sections of average consistency and blood-colored rag. It is rich in juice and has a very agreeable flavor; seeds absent or nearly so. The resistance of the fruits to transportation is limited; they are well adapted to candying or preserving and to the manufacture of marmalade.

It is a variety of normal yield and medium early maturity. Picking is done from December to March.

XVII. Sanguigni di spina or di "ariddu" (A blood orange)

As in the case of the thorny blonds, the thorny bloods (sanguigni) do not represent a true and genuine variety, but a group of varieties. Since they have all originated from seed or from grafting with buds taken from trees grown from seed, they present common characteristics such as hardiness and behavior of the trees, thorns, in early ripening, high productivity, etc.

Further Identification of Italian Orange Varieties

A study of the pigmentation in Italian oranges by Vincenzo Carrante contains some excellent data which further identify Italian orange varieties

and also indicate climatic influences on citrus maturity. A translation of the conclusions of this study, together with tabulations of the fruit characteristics as determined by laboratory tests, is given below.

Pigmentation in Italian Oranges 9/

1) The pigmentations of the oranges are linked to two fundamental groups of pigments, one of which is basically orange-yellow (carotenoids) and relates to blonds and bloods, and the other, with a basically red color (anthocyanins) applies exclusively to the bloods. While a high and peculiar biological value is recognized for the carotnoids - that of provitamin A - for which reason it has been adopted by the 1931 and 1934 International Congresses of London as a basis for the evaluation of vitamin A, no vitaminic function has been attributed to the anthocyanins. However, these exercise a function of beauty and attractiveness which it is far from possible to neglect in making a commercial appraisal of the oranges.

2) The carotenoid or provitamin A, content proves high in the blond Italian oranges, and especially so in some of the bloods, which represent a peculiar specialization in Italian production and exportation of oranges.

3) On the basis of the vitamin equivalent established by the above-mentioned International Congresses of London, it can be determined that, per liter of juice, the Italian oranges analyzed - Moro, Tarocco, Sanguinello Moscato, and Biondo comune - contain from about 2,500 to about 5,700 international units of vitamin A, with the minimum referable to the first stages of maturity. They have a sugar-acid ratio of about 5-7, and at the maximum the last period of commercial maturity the sugar-acid ratio reaches about 7-10.

4) The Italian oranges, compared with those from Florida and California, have demonstrated that they possess a higher vitamin power, their carotenoid content being double to triple that of the North American oranges.

5) The carotenoid and xanthophyll content, percentage of juice, and values of the sugar-acid ratio increase with the progress of the ripening of the oranges and rise as the fruits mature.

6) The keeping of oranges in cold storage at 4° C. (39.2° F.) has an influence on the increase in the content of carotenoid during the first 20 days, after which such content diminishes for catabolic reasons.

The pH values of the juice diminish from 2.26 to 5.05, indicating that the potentiometric acidity, although diminishing with the progress of the maturity, is sufficently high at the end of the manifestation of the intense red coloration of the anthocyanins.

7) The two pigments of the carotenoid group which have been subjected examination (carotene and zanthophll) are not transformed, one into the other, and probably derive origin from a common intermediate chromogenic

9/ Vincente Carrante, Sulle Pigmentazioni delle Arance Italiane, R. Stazione Sperimentale di Frutticoltura e di Agrumicoltura, Acireale. Translated from the Italian by Mey Coult.

Table 8. - Sample Italian Oranges from Trees and from Packing Houses, Carotenoids, Xanthophyll, Juice Percentage, and pH, Monthly Averages for the 1938-41 Crop Years

Orange sample	November				December				January				February				March				April				May			
	Carotene	Xanthophyll	Juice	pH	Carotene	Xanthophyll	Juice	pH	Carotene	Xanthophyll	Juice	pH	Carotene	Xanthophyll	Juice	pH	Carotene	Xanthophyll	Juice	pH	Carotene	Xanthophyll	Juice	pH	Carotene	Xanthophyll	Juice	pH
	Mg/liter	Mg/liter	Per-cent		Mg/liter	Mg/liter	Per-cent		Mg/liter	Mg/liter	Per-cent		Mg/liter	Mg/liter	Per-cent		Mg/liter	Mg/liter	Per-cent		Mg/liter	Mg/liter	Per-cent		Mg/liter	Mg/liter	Per-cent	
	Samples from trees																											
Moro																												
(Lentini)																												
(Blood)	0.934	0.223	46.96	2.72	1.125	0.550	43.68	3.80	1.343	0.466	42.63	3.65	2.199	0.667	41.27	5.02	3.379	0.883	43.57	4.97	3.323	1.301	37.35	4.90	-	-	-	-
Tarocco																												
(Lentini)																												
(Blood)	0.835	0.165	37.30	2.87	1.472	0.581	40.97	3.75	1.944	0.554	40.75	3.95	2.408	0.792	39.52	4.75	3.374	1.051	40.70	4.98	3.489	1.250	37.75	5.00	-	-	-	-
Sanguigno																												
(Reggio Cal.)																												
(Blood)	-	-	-	-	1.909	0.901	48.75	4.25	2.040	1.090	47.57	4.69	2.588	1.260	47.63	5.00	3.059	1.145	44.22	5.17	3.960	1.366	43.04	5.05	-	-	-	-
Sanguigno Moscato																												
(Paterno-Lentini)																												
(Blood)	-	-	-	-	1.276	0.812	41.58	3.19	1.471	0.484	36.55	4.59	2.199	0.271	39.55	4.59	2.505	0.709	37.99	4.31	3.003	0.938	37.02	4.31	-	-	-	-
Biondo																												
(Paterno-Lentini-Reggio Cal.)																												
(Nonblood)	0.377	0.285	46.31	2.81	1.582	0.593	42.66	3.56	1.766	0.566	37.65	4.70	2.067	0.744	40.30	4.56	2.801	0.742	38.48	4.53	3.445	1.028	41.59	4.41	-	-	-	-
	Samples from packing house																											
Sanguigne																												
(Sicilia)																												
(Blood)	1.259	0.841	46.95	3.42	1.552	0.987	44.13	4.20	1.519	0.626	42.86	4.32	1.889	0.473	40.50	4.76	2.108	0.871	41.56	4.59	3.002	1.086	35.81	5.00	-	-	-	-
Biondo																												
(Sicilia)																												
(Nonblood)	-	-	-	-	1.384	0.948	35.71	4.22	1.745	0.719	39.21	4.31	2.093	0.619	38.76	4.53	2.644	0.864	38.98	4.63	3.204	1.327	45.01	4.55	-	-	-	-
Biondo																												
(Calabria)																												
(Nonblood)	-	-	-	-	-	-	-	-	1.651	0.331	35.47	4.20	1.729	0.582	42.24	3.97	-	-	-	-	2.481	1.002	43.72	4.59	-	-	-	-
Biondo																												
(Campania)																												
(Nonblood)	-	-	-	-	-	-	-	-	1.714	0.399	35.92	4.61	2.050	0.427	37.77	4.14	1.644	0.656	34.01	5.43	-	-	-	-	2.120	1.265	41.39	4.10
Biondo																												
(Lazio)																												
(Nonblood)	-	-	-	-	-	-	-	-	2.023	0.337	39.04	3.69	1.814	0.707	40.14	3.92	2.561	0.631	35.43	5.22	-	-	-	-	1.610	0.880	36.88	3.39

Source: V. Carrente, op. cit.

Table 9. - Sample Italian Oranges from Trees and from Packing Houses, Sugar, Acid, and Sugar-Acid Ratio
Monthly Average for the 1938-41 Crop Years

Orange sample	November			December			January			February			March			April			May		
	Sugar	Acid	Sugar-Acid ratio	Sugar	Acid	Sugar-Acid ratio	Sugar	Acid	Sugar-Acid ratio	Sugar	Acid	Sugar-Acid ratio	Sugar	Acid	Sugar-Acid ratio	Sugar	Acid	Sugar-Acid ratio	Sugar	Acid	Sugar-Acid ratio
	Samples from trees																				
Moro (Lentini) (Blood)	11.60	1.78	6.52	10.60	1.58	6.73	10.83	1.78	6.19	11.19	1.41	8.12	11.77	1.17	10.06	11.52	1.15	10.03	-	-	-
Tarocco (Lentini) (Blood)	11.10	2.23	5.05	9.92	1.70	5.96	10.42	1.72	6.11	10.84	1.41	7.76	11.65	1.17	10.02	12.52	1.19	10.51	-	-	-
Sanguigno (Paterno-Reggio Cal.) (Blood)	-	-	-	10.60	2.47	4.38	11.47	1.89	6.06	11.56	1.50	7.75	12.86	1.38	8.57	12.12	1.13	10.88	-	-	-
Sanguinello Moscato (Paterno Lentini) (Blood)	-	-	-	11.96	3.12	3.92	12.43	2.47	4.95	13.14	2.24	5.29	13.53	2.03	6.80	13.30	1.78	7.47	13.5	1.60	8.45
Biondo (Paterno-Lentini-Reggio Cal.) (Nonblood)	13.05	2.57	5.31	11.34	2.75	4.28	12.01	2.64	4.85	12.79	2.19	6.38	13.31	1.98	7.31	13.58	1.52	10.28	13.2	1.85	7.07
	Samples from packing houses																				
Sanguigne (Sicilia) (Blood)	11.66	2.11	5.50	12.18	1.77	6.72	11.34	2.01	5.64	12.97	1.84	7.09	12.52	1.55	8.19	12.65	1.38	9.31	-	-	-
Biondo (Sicilia) (Nonblood)	-	-	-	11.30	1.74	6.53	11.29	2.05	5.79	13.28	2.01	6.64	12.42	1.65	7.76	12.84	1.24	10.31	-	-	-
Biondo (Calabria) (Nonblood)	-	-	-	-	-	-	11.41	1.66	6.89	12.02	1.68	7.45	-	-	-	11.48	1.09	10.55	12.45	0.80	15.15
Biondo (Campania) (Nonblood)	-	-	-	-	-	-	10.97	1.71	6.52	11.26	1.48	7.71	12.05	1.49	8.63	-	-	-	10.65	0.86	12.44
Biondo (Lazio) (Nonblood)	-	-	-	-	-	-	11.20	3.69	6.40	11.90	1.52	6.53	12.15	1.24	10.80	-	-	-	11.80	1.00	11.80

Source: V. Carrante, op. cit.

substance which - under the influence of the cellular metabolism - through the phenomena of synthesis and oxygen reduction (ossiriduzione) produces one or the other of the carotenoids.

8) The anthocyanin pigmentations of oranges are linked in quantity and time of formation principally to the genetic factor: They are noted first and are more intense in the oranges of the Moro variety (December) and successively in the "Sanguigno comune", "Tarocco", and "Sanguinello Moscato" varieties. However, there are factors of season, environment, and physiology which are capable of promoting or attenuating such varietal characteristics. Among them are the following a) The favorable action of cold, light days during the period of the coloring of the fruits (from October on) which precedes the formation of the anthocyanin chromogenes, either of the epicarp or the endocarp, because of the action of the saccharophylly and the prevalence of the oxydizing processes; b) the action of the fertilizers containing phosphate and potash which increase the amount of the pigmentations; c) all the factors and practices of a cultural nature which can bring about an increase in the sugar content of the fruits, determining conditions favorable to the formation of the anthocyanins whose glycidic nature and molecular structure can explain their origin as a product of reduction of the flavones and combination with the sugar; d) the regrafting of some blood varieties, e.g., Tarocco on citron (Citrus medica L.), which for reasons not yet explained, causes an appreciable advance over normal in the appearance of the anthocyanian pigments.

9) Aside from the factors mentioned in (8) above the anthocyanin pigmentations increase gradually as the maturity of the orange progresses. Among other things, this permits an increase in sugars, reduction in total acidity and potentiometric acidity and decrease in the reducing power of the chromoplasts which continue to disappear with advantage to the enzymatic oxydizing action of the "chromogen" from which, according to Wheldale, the anthocyanins derive.

10) It can be definitely established (paragraphs 8 and 9 above) that the increase in the anthocyanin pigmentations of the oranges is dependent on the increase of the sugars in the fruits, and that therefore the practices, direct or indirect, which can determine it are in part at the disposal of the orange growers who wish to obtain crops more richly pigmented.

Other Citrus

The Bergamot. Bergamots are an unusual citrus fruit grown exclusively for the production of essential oils and calcium citrate. This variety is produced commerically on the Italian peninsula, primarily in the coastal zone near Reggio Calabria, from Villa S. Giovanni to Gloiosa Ionica. There are very few plantings of this variety in Sicily, as it does not produce well there.

The varieties cultivated, according to Annali of the Experiment Station at Acireale in 1935, are the Castagnara and the Femminella. These were selected for their productivity and yield of essential oils. The fruits are usually harvested in December and January.

In September 1949, commercial bergamot orchards were observed near Reggio Calabria. Like the Italian lemon and orange, it is propagated on sour orange stock. In appearance the trees are very much like the comune lemon or old seedling lemon trees seen in California. The cross-section of the limbs is oval, almost tear-shaped on some trees, with the sharp edge at the top of the limb. Mature trees are large, 15 to 20 feet tall, with trunks 8 to 10 inches in diameter. The foliage is a typical lemon type, and when seen most trees had a very light leaf population. This was probably an abnormal condition, since the groves had been damaged by the snow and frost of March 5, 1949.

The tree trunks and limbs are a different color than the lemon tree, the bark having a slightly orange tint. The limbs grow upright from the tree trunk, as do those of the comune lemon. The Italian bergamot trees are so similar to lemon trees it is extremely difficult to differentiate between the two varieties from a distance.

Bergamot fruits seen in September 1949 were squat, dark green, and lemon shaped. They were not as elongated as a lemon, being nearly spherical, but they had the typical lemon blossom-end. The blossom-end nipple was slightly recessed in some of the fruits. The bergamots were about the size of 344 California oranges.

The author has never seen the mature bergamot, but it is his opinion that it is also dark green at the time of harvest, which may not be full maturity, since the essential oil of the bergamot is a deep green, much deeper green than the oil of Italian lemons. Italian lemons are not a cured fruit, and therefore have more green pigment in the peel at the time of processing than the average California fruit.

The Chinotto orange. This orange variety is grown in the province of Liguria. It is very resistant to frost damage but does not produce large crops. The fruit is not used fresh but for candies and marmalades. It is of very minor importance.

Grapefruit. Grapefruit is grown to a very minor extent in Liguria, Campania, and on Sicily at Lentini, Agata, and near Catania. Marsh seedless is the most common variety, but a few Duncan, Pernambuco, Royal, Triumph, McCarty, and Foster trees are to be found.

Citron. Citron is another minor citrus fruit grown primarily on the Italian mainland in the province of Calabria. The principal varieties cultivated are the Liscia and the Diamante. These produce good crops regularly. The fruit is of fine quality with an intense aroma. Because the citron is very sensitive to frost, it is planted near the coast on ground which is high enough to have good cold air drainage. Plantings are made at elevations up to 1,000 feet. Because of the mountainous terrain of both Sicily and Italy high elevations are found quite near the seashore.

This fruit is grown for industrial purposes such as peel products and essential oil.

Bitter orange. The bitter or Seville orange is grown in Reggio Calabria, Barcellona, near Messina, and at Augusta, Siracusa, Avala, Noto, Fiumefreddo, and Monreale, but it is a minor crop in all districts. It is grown for industrial purposes, the blossoms being used to produce neroli and orange flower water and the leaves for petit grain. The fruit may be used for marmalades.

This variety has been attached by mal secco and the acreage somewhat reduced in recent years.

Sweet Lemon. This variety is produced sporadically in many citrus producing districts. It is a very minor crop and the production is consumed locally.

COST OF PRODUCTION

Information on the economic aspects of the industry is not available from official sources. The following data were therefore obtained in the field from trade sources and correlated with observation. The cost data presented here are believed to be about as reliable as can be obtained under present conditions.

Information on cost of lemon production was obtained from many trade sources and costs were used only when they had been corroborated by interviews with growers. All of these cost figures should be considered conservative, however, since the author is certain that the Italians reduce cost on grove operations in many ways which are not apparent to the visitor.

These cost data are presented in the only way which seems feasible, by recounting cost and yield factors as they were encountered on the several properties visited or made available by other trade sources. This method of presentation may not result in a neatly summarized cost calculation, but it is hoped that the costs and other information as observed in groves will provide some understanding of the way in which an Italian citrus grove operates.

It should be kept in mind that the Italian citrus groves are small properties and are operated primarily by owners or renters who have been in possession for a long time. It should also be kept in mind that the property which is planted to citrus also produces other crops of foodstuff which help sustain the family, and a real income is therefore obtained from the property which is not apparent in revenue from the sales of citrus.

The examples of grove operation, production, and costs are stated in detail in order to give an account which is as realistic as possible. The average Italian lemon grove produces other commercial crops besides the main crop of citrus. Olive and walnut trees are commonly grown in conjunction with citrus culture, and grapes and vegetables are planted in groves.

This practice of interplanting is so extensive that, from observation, at least 25 percent of the income of the average citrus grove must be derived from crops other than citrus, either through the sale of these crops or the value of produce raised in the grove and consumed by its operators. This is a conservative estimate and must be considered in any discussion of the cost of citrus production.

In considering the quantity of fruit produced per acre, the following examples of grove operation will be helpful. To be considered with this evidence is the fact that when exporters were asked the average production of lemons per hectare, almost without exception they gave 30 metric tons per hectare (352 boxes of 76 pounds each per acre) as the average production.

The average grove contains 400 to 600 trees per hectare (162 to 243 trees per acre). When asked about the quantity of fruit picked per tree the most frequent reply was 50 kilograms, (110 pounds), or 30,000 kilograms per hectare (352 boxes per acre). Personal inspection of the groves confirms these estimates as being conservative. Many groves seen would produce much larger crops.

These groves are all hand-cultivated, and no space is wasted. Under hand cultivation, areas may be used for citrus culture which could not be cultivated with mechanical tools. Land is utilized to a very high degree, and this is reflected in production.

First we shall list some of the important cost items which must be considered, in the production of lemons in Italy.

Following this, we shall discuss these factors as they were observed being applied on several representative groves in the more important lemon districts.

Some Production Cost Factors

Below are listed some of the wage and material costs in 1949 which enter into the cost of citrus production in Italy. These are in accordance with quotations obtained by the American Consulate General at Palermo on August 26, 1949, from the Consorzio Agrario of Palermo.

Wages of field labor	600 lire per day	$1.04
Wages of fumigating labor	700 lire per day	$1.22
Wages in packing house		
(women)	600-700 lire per day	$1.04-$1.22
(men)	600-1,200 lire per day	$2.09
Spray oil	320 lire per kilo	$2.27 per gallon
Sulphate of ammonia	4,900 lire per quintal	$0.04 per pound
	49 lire per kilo	$0.04 per pound
Superphosphate	1,800-1,900 lire per quintal	$0.014-$0.015 per pound
Manure (20 kilo basket)	40 lire per basket	$0.07 per basket
Hail insurance	2% to 3% of crop value	

Examples of Production Cost

The author was extremely fortunate in being able to visit Sicilian lemon groves and to make substantiating observations regarding the cost data. It will be noted that the data for the six groves described below are not comparable in all instances, but this could not be expected, since the information was obtained in the field and represents the differing conditions at the groves. These groves are widely dispersed among the important lemon producing districts in Sicily, and they should therefore give the effect of a random sample to the data provided.

In all cases the operation of the grove and the cost factors have been described in as much detail as possible, since one factor is a function of the other. These data should give quite typical illustrations of the cost of operation, the yield of groves, the cultural methods, and the labor load necessary for their operation.

1. Messina 1/

This grove near the town of Messina is devoted entirely to lemon culture, and the trees are about 40 years old. This grove is in tax classification II and is partially affected by mal secco. The area of the grove is 2.63 hectares (6.5 acres).

Production for 1945-46 to 1947-48, in "thousands" (1,040 lemons) weighing approximately 120 kilos, was as follows:

	"Thousands"	Kilos per hectare	Boxes per acre
1945-46....	400	17,400	204.26
1946-47....	360	16,320	191.59
1947-48....	380	17,280	202.86

To cultivate this 2.63-hectare grove, 600 working days were required for all cultural work and harvesting. This is equivalent to 92.3 working days per acre. The expenses of operation were as follows.

	Lire per hectare	Dollars per acre
Labor and manure ...	163,498	115.05
Irrigation (water) ,	4,563	3.21
Taxes	53,992	37.99
Total	222,053	156.25

2. Villafranca 1/

This grove near Villafranca, devoted entirely to lemon culture, is in tax classification II, and is only slightly affected by mal secco. It is 1 hectare (2.5 acres) in size.

Recent production of lemons was as follows:

	"Thousands"	Kilos per hectare	Boxes per acre
1945-46....	300	36,000	422.62
1946-47....	270	32,400	380.35
1947-48....	240	28,800	338.09

To cultivate this 1-hectare grove, 400 working days were required, or 160 working days per acre. Included in this is the time required for harvestings.

1/ Information from trade sources.

The following costs were incurred:

	Lire per hectare	Dollars per acre
Labor and manure....	300,000	211.14
Irrigation (water)..	50,000	35.19
Taxes.....	45,000	31.67
Total.....	395,000	278.00

3. Fiumefreddo 2/

This grove near the town of Fiumefreddo is devoted entirely to lemons and is irrigated by gravity water obtained from a river. It is in tax classification III, and has only recently been infected with mal secco. The grove is 19 hectares (47 acres) in area.

Recent production was as follows:

	"Thousands"	Kilos per hectare	Boxes per acre
1943-44....	3,000	18,840	221.17
1944-45....	3,500	22,080	259.20
1945-46....	2,250	14,160	166.23
1946-47....	2,500	15,720	184.54
1947-48....	2,600	16,320	191.59

To cultivate this grove the following expenses were incurred:

	Lire per hectare	Dollars per acre
Labor and manure....	35,000	24.63
Irrigation water.... (river)	1,500	1.06
Taxes.....	25,000	17.60
Total.....	61,500	42.29

These low costs must be considered as unusual and representative of only a small percentage of Italian lemon groves.

4. Bagheria 3/

The grove visited at Bagheria near Palermo is a partially terraced planting with fairly large trees about 12 feet tall on the average. Some of the grove is old, with lemons top-worked on orange trunks approximately 100 years old.

This grove is irrigated five times a year on the average between April and October. The cost of water is high, since it has to be pumped from the ground and then forced to some 300 feet above the pumping plant, through a 10-inch steel pipe under pressure. The pumping plant is an impressive installation containing what appeared to be a 1,000- horsepower Diesel engine to furnish power. This grower also supplies water to surrounding groves.

2/ Information from trade sources.
3/ Information from personal observations.

The pumping facilities furnish 40 cubic meters of water per hour. At this rate it would require 5 hours to irrigate 1 hectare or about 2 hours to irrigate 1 acre. The cost of the water was 1,300 lire ($2.26) per hour, which is 43.3 lire ($0.08) per tree per irrigation. The cost of irrigating 1 hectare containing 600 trees would be 129,000 lire ($224.35) per hectare for the five irrigations ($90.79 per acre).

The grove is cultivated by hand and requires an average of 333 man days of labor per hectare per year (135 man days per acre) for cultivation, spraying, pruning, harvesting, etc.

This grove is manured every 2 years, and two applications of sulphate of ammonia are made each year, totaling 4 kilos (9 pounds) to each large tree or 2,400 kilos per hectare (2,141 pounds per acre).

This is an excellent grove, and the grower estimated that production would average about 35,000 kilos per hectare a year. At an average price of 30 lire a kilo, taking into account the high price of the verdelli fruit, the yearly income from lemons would be 1,050,000 lire per hectare ($739.01 per acre). This is only the income from lemons; the grove contained olive trees from which additional income would be derived.

On the basis of this information, the costs of operation may be calculated as follows:

	Lire per hectare	Dollars per acre
Labor (700 lire per day).....	233,100	164.06
Water (5 irrigations)	129,000	90.79
Fertilization.....	129,600	91.21
Taxes, estimated....	50,000	35.19
Total.....	541,700	381.25

This grove is sprayed every other year in addition to fumigation every 3 years. The grove was in excellent condition, with little evidence of disease. Only one small outbreak of mal secco had been observed in the last 5 years.

5. Roccalumera 4/

The orchard visited near Roccalumera was an old one which had been partly destroyed by mal secco. Here, some replants of the Monachello variety are 15 years old. In this terraced grove the soil is light, in places almost gravel, and Verdelli culture is practiced. This grove is 8 hectares (20 acres) in area.

This is an excellent example of an average grove, and the cost and earnings figures should be quite typical.

To cultivate this grove required 61 months, or 1,586 days at 26 days a month.

4/ Information from personal observations.

Irrigation water costs 2,000 lire per hour, and it takes 3 hours to irrigate 1 hectare, or 24 hours to irrigate the 8 hectares (20 acres).

One thousand kilos of sulphate of ammonia are applied per hectare (892 pounds per acre).

Cost of production is summarized below:

	Lire per hectare	Dollars per acre
Labor.....	18,200	12.81
Irrigations (6 per year).....	36,000	25.34
Fertilizer.....	49,000	34.49
Taxes.....	50,000	35.19
Hail insurance.....	7,000	4.93
Rent and other.....	25,000	17.59
Total.....	185,200	130.35

Average production is as follows:

	"Thousands"	Kilos per hectare	Boxes per acre
Verdelli....	37	4,440	52.12
Winter.....	50	6,000	70.44
Total....	87	10,440	122.56

The grower stated that the verdelli were sold for an average of 50 lire per kilo and the regular bloom or winter fruit for an average of 25 lire per kilo. On the basis of 4,440 kilos of verdelli at 50 lire per kilo and 6,000 kilos of winter lemons at 25 lire per kilo, the gross income would be 372,000 lire per hectare ($261.82 per acre), and cash earnings after expenses would be 186,800 lire per hectare ($131.47 per acre).

6. Carini

The grove visited near Carini was a mixed planting of lemons, olives, and grapes. From inspection, it is estimated that lemon production would average about 10,000 kilos per hectare (117 boxes per acre).

The following costs were obtained from the grove accounts. The costs from November 24, 1948, to August 25, 1949, were approximately 80,000 lire per hectare ($56.31 per acre). At this rate of expenditure the year's cost of operation would be 106,664 lire per hectare per year ($75.07 per acre). Adding 60,000 lire for taxes, the growers' stated rate, the total cost of operation per year is approximately 166,664 lire per hectare ($117.30 per acre).

The actual income from the grove from November 24, 1948 to August 25, 1949 was 248,763 lire per hectare ($175.08 per acre). In August there remained at least 1,000 kilos of verdelli lemons to be harvested per hectare, and at that time verdelli were bringing a price of 40 lire per kilo

($0.03 per pound) to the grower. A conservative estimate of additional income to November 24, 1949 would be 40,000 lire per hectare ($28.15 per acre), bringing the total estimated 12 months income to 288,763 lire per hectare ($203.24 per acre).

These calculations indicate the following expenses and income from this grove:

	Lire per hectare	Dollars per acre
Income 1/	288,763	203.24
Expenses	166,664	117.30
Returns	1/ 122,099	1/ 85.94

1/ Cash income; does not include amortization, interest, etc.

Table 10. Italy: A Summary of the Cost Data of Six Lemon Groves

District	Production 1/		Expenses		Cost of production 2/		
	Kilos per hectare	Boxes per acre	Lire per hectare	Dollars per acre	Lire per kilo	Dollars per 76-lb. box	Dollars per 66-lb. box
Messina	17,280	202.86	222,053	156.25	12.7	0.76	0.66
Villafranca	28,800	338.09	395,000	278.00	13.7	0.84	0.71
Fiumefreddo	16,320	191.59	61,500	43.29	3.76	0.22	0.20
Bagheria	35,000	410.88	541,700	381.75	15.4	0.91	0.81
Roccalumera	10,440	122.56	185,200	130.35	17.74	1.06	0.92
Carini	10,000	117.39	166,664	117.30	16.6	1.00	0.86
Average	19,640	230.56					

1/ 1947-48.
2/ Costs are given in both the United States statistical box weight unit of 76 lb. and the Italian box weight of 66 lb.

Computed Cost of Hypothetical Grove

The six groves described above are representative of Italian lemon production, and the costs are actual figures. From these costs, other information from trade sources, and personal observations the following hypothetical grove cost has been constructed.

	Lire per hectare (500 trees)	Dollars per acre (202 trees)
Labor, 300 days at 700 lire per day (includes cultivation, pruning, spraying, and harvesting)	210,000	147.80
Irrigation, pumped water	50,000	35.19
Fumigation at 1/3 of 200 lire per tree	33,333	23.46
Spraying material	2,000	1.41
Manure, 1 basket per tree per year	20,000	14.07
Sulphate of ammonia (2 kilos per tree at 49 lire per kilo)	49,000	34.48
Taxes - Class II grove	50,000	35.19
Hail insurance	5,000	3.52
General	10,000	7.04
Total	429,333	302.17

The average production may be conservatively estimated at 20,000 kilos per hectare per year, which will cover the production decrease which has occurred in some groves due to mal secco and will be less than the generally estimated 30,000 kilos production which exporters say is average.

The above cost of 429,333 lire per hectare has been computed high, including heavier fertilization than is average and greater than average labor and pest control costs. Even at this cost, with a production of only 20,000 kilos per hectare (235 boxes per acre), the cost of production is 21.46 lire per kilo, or $1.28 per 76-pound box $1.12 per 66-pound box.

Not mentioned in either this computation or the six examples is the item of rent. Where groves are rented, this factor is compensated for to a large degree by the item of labor. Since the renter is also a grove worker and since the groves are small, averaging about 1 hectare (2.5 acres), the saved labor cost largely compensates for rent.

A still more important factor which has not been considered is mixed culture and its effect on costs. As stated before, most groves are mixed plantings, and crops other than citrus return an income of approximately 25 percent of the value of the citrus crop, on the average. Applying "other income" to the computation of production cost reduces the cost of the main cash crop - lemons.

	Lire per hectare	Dollars per acre
Cost of production	429,333	302.17
Less income from other crops (25 percent)	107,333	75.54
Effective cost	322,000	226.63

Therefore the cost of lemon production is much less than if lemons were the only commercial crop. Thus, with the estimated production of 20,000 kilos per hectare (234.8 boxes per acre) the cost of production becomes 16.1 lire per kilo ($.0127 per pound or $0.97 per 76-pound box).

Computation of a Range of Break-even Costs

From the summary of the costs on six representative groves (Table 10), it will be noted that there is a high correlation between the expenses of grove operation and yield. While there is a very great difference in expenses of operation, there is not such a difference in the cost of production per kilo or per box, because the greater care has usually resulted in a much greater yield.

It will also be noted in this summary that, excluding the data from Fiumefreddo, which must be considered as exceptional, the range of the cost of production on the other five groves is relatively small. The cost of production for these five groves ranges from $0.66 to $0.92 per 66-pound box, a difference of only $0.26; and from $0.76 to $1.06 per 76-pound box, a difference of only $0.30. To be conserative the range of costs selected as representative of a significant percentage of Italian lemon groves is both slightly higher and lower than the range of costs of the five representative groves described above. The cost figures thus arrived at cover a range which may be considered as representative of a major portion of Italian lemon groves in 1949. Where cost factors involve the tree unit, the high tree count of 600 per hectare has been used.

Considering the evidence, the range of the break-even cost of production is conservatively estimated as follows:

	High		Low	
	Lire	Dollars	Lire	Dollars
1 kilo	20	-	12	-
30-kilo (66 lb.) box	600	1.05	360	0.63
76-lb. box	-	1.23	-	0.74

The following computation of the break-even costs of boxes of Italian lemons, f.o.b., Italian ports, in 1949 is based on the above range of production cost and the packing costs itemized in Table 12 (Marketing section). This range will include the costs incurred in the export of the majority of Italian lemons.

	30-kilo (66 lb.) box		76-lb. box	
	High	Low	High	Low
	Dollars	Dollars	Dollars	Dollars
Cost of fruit	1.05	0.63	1.23	0.74
Cost of packing	1.14	0.86	1.31	0.99
Total cost, f.o.b. Italy	2.19	1.49	2.54	1.73

Considering the above costs f.o.b. Italian ports, as well as the freight rates listed in Table 14 (Marketing section), the range of break-even costs for Italian lemons in export markets may be computed as follows:

	Cost f.o.b. Italian ports plus freight	
	High	Low
Paris	2.76	2.06
Brussels	3.14	2.44
Frankfurt	2.90	2.20
London or Liverpool	2.70	2.00
Gothenburg or Copenhagen	3.03	2.33
New York	3.34	2.64

At these cost levels, the Italian lemon is highly competitive in all European markets and in the United States. The break-even costs of Italian lemons unloaded at New York (see below) are probably lower than the average break-even costs of California lemons at New York.

	Cost, unloaded at New York			
	66-lb. box		76-lb. box	
	High	Low	High	Low
	Dollars	Dollars	Dollars	Dollars
Cost of lemons, f.o.b. Italian ports	2.19	1.49	2.54	1.73
Freight from Italian ports to New York common stowage	1.15	1.15	*1.15	*1.15
New duty effective 1950*	1.25	1.25	*1.25	*1.25
Handling and cartage from ship to time of sale	.50	.50	*.50	*.50
Auction commission (3/4 percent)*	.10	.10	*.10	*.10
Receivers commission (5 percent)*	.25	.25	*.25	*.25
Total	5.44	4.74	*5.79	*4.98

* Estimated.

The break-even costs as computed, do not allow for profit either by the grower or the exporter. Since the exporter has to have a profit for his services and the grower seldom has to sell his fruit at prices which return only the cost of production, most Italian lemons will have to sell at higher than indicated break-even prices in order to make some profit for the exporter.

This assumes that there is no subsidy or other premium on foriegn exchange which would be available to the exporter as a source of profit.

For several years, the Italian Government has operated a program to stimulate dollar earning exports. Under this plan, the Italian exporter of lemons to the United States is credited with half of the dollar earnings of his lemon export sales. These are not free dollars to be disposed of by the exporter, but are a source of foreign exchange which the exporter can use to purchase merchandise for import into Italy. These export dollars must be used in three months by the exporter. Import licenses have to be obtained for such imports, therefore, some persons interviewed in Italy said there was no advantage to the exporter in using these export dollars. Others indicated that items of high profit could be imported with these export dollars because having the earned dollars made it easier to obtain import licenses for such high profit items.

The fact that this program is still in operation seems to indicate that there must be some advantage in using the export dollar. If there is a profit obtained by the exporter, then the break-even cost factors would have to be adjusted by the amount of that advantage in order to have a realistic break-even cost estimate.

MARKETING OF ITALIAN LEMONS

The Italian lemon industry consists of many small factors. The lemon gardens are numerous and probably do not average five city lots in size. These growers are unorganized, and they sell their fruit individually to buyers and exporters.

Selling

The fruit is sold in several ways. Some exporters buy an entire crop on the tree for a flat price. In such cases, it is customary for the purchaser to place a guard in the grove until the fruit is picked.

In other cases, the fruit is sold by weight delivered to the packing house. Or the unit of sale may be a "thousand" (1,040 lemons), which may weigh from 110 to 130 kilos (243 to 287 pounds) depending on the fruit size. For statistical purposes a "thousand" of 1,040 lemons is considered to weigh 120 kilos, or 265 pounds.

In still other cases, the fruit is sold to a fruit buyer who, in turn, sells to an exporter. The reason for the existence of such an intermediary is the small size of the average grove. An exporter, having an order for 1,000 boxes of lemons, might need to contact 50 growers to obtain the fruit. In such cases, the job may be given to the fruit buyer.

Picking

Fruit is picked by farm employees or employees of the fruit buyer, including boys as well as men and women. Lemons are picked by breaking the stem by hand and placing the fruit in baskets which hold about 30 pounds. On most of the large lemon trees ladders are used. The picked fruit is taken in baskets to a central location in the orchard, where women clip the broken stems from the fruit and place the fruit in a pile under the tree. Later the fruit is placed in large wicker hampers and is carried to the packing house either by two-wheeled carts or donkeys.

In orchards visited where picking was in process, it was pointed out by growers that fruit from mal-secco infested trees sheds the button in the picking process. In lemon packing houses, inspectors were able to identify fruit with shed buttons having a slight pink pigmentation in the button socket, as from mal-secco infested trees.

Packing

Italian lemon packing houses are very simple installations which utilize a great deal of hand labor; none of those visited had packing or washing machinery. Low, padded troughs, placed in rows approximately 4 feet apart, are used in the packing and grading process. These troughs are about 3 feet wide at the top and approximately 18 inches deep.

When the fruit is received at the packing house, it is usually piled loose on straw in a corner of the building. If the condition of the fruit makes it necessary, women may select and wipe the dirty fruit and remove with their fingernails any adherent scale.

In the packing process the lemons are dumped in the first trough. Women sight, grade, and size the fruits, and place them in a second trough. At the other side of this trough, women wrap the fruit tightly and place it in the next trough. The fruit is then transferred to a box and tightly packed. Decorated labels are usually placed on top of the box, and the packed box is then placed on the bench beside the trough, the lid is applied, and the split willow bands are nailed down. 1/

In exceptional cases, large growers may have "magasins" or private packing houses in their groves where they pack their own fruit and sell by box to the exporters.

Oranges and lemons are prepared for market in a similar manner. Lemons are almost always packed full wrapped in cases for export; for the domestic market they may be sold loose if it is only a short haul to market, or in summer may be packed in approximately 40-pound baskets for shipment to Rome and other Continental cities.

Oranges are packed in boxes for shipment to most European countries, such as the Netherlands, Belgium, Denmark, Norway, Sweden, and England. However, oranges shipped to Western Germany and Switzerland may be sent in bulk. Fruit shipped in this manner is harvested in the orchard and taken immediately to rail cars, where it is dumped, usually ungraded and unwashed. Fruit is piled in the cars approximately 4 feet deep. In winter the cars are lined with straw and paper to protect against frost, and the fruit itself is always covered with straw and paper. Bulk shipments were inspected in Frankfurt, and the fruit showed little if any decay. This is an inexpensive way of bringing the product from producer to consumer, and an effective one in a country such as Germany where the fruit is distributed rather rapidly.

Packing Counts and Grade Indications

Italy and Sicily have certain generally accepted grade and size designations. Lemons are commonly exported in one of two grades: "prima" indicating first quality fruit, and "seconda" for export fruit of a lower grade

1/ These bands are called "chestnut" by the trade, but are probably willow and hazelnut.

Italian citrus packed in a box or in a "cassette" (a basket pack weighing about 40 pounds, which is used for Italian markets) is usually shipped in the following counts:

Fruit	Package count
Lemons in "cassette"	120-136-150-180-252-280
Lemons in boxes	240-270-300-360-440-490
Oranges in "cassette"	40-48-50-60-70-108-126-144
Oranges in boxes	80-96-126-150-176-216-252-288
Tangerines in "cassette"	60-72-84-96-112-120-140-168

In lemon exports, the fruit is sometimes shipped in a "large" or "extra large" case. (See Table 11 for inside dimensions of standard Italian citrus export boxes). The same fruit counts are used, but larger fruits are packed in a larger box. Thus, a box of 300 lemons weighs 37 kilos (82 pounds), a box of 300 "large" weighs 44 kilos (97 pounds), and a box of 300 "extra large" weighs 55 kilos. (121 pounds).

This system of sizing fruit makes for complicated shipping sizes. It was probably designed, however, to suit the European market, as some countries pay a premium price for very large lemons, larger fruit than is ever sold in United States markets.

Table 11.-Italy: Inside Dimensions of Standard Italian Citrus Export Boxes

Box	Length	Width	Height
	Inches	Inches	Inches
For lemons			
Box No. 1	24.8	12.6	5.5
Box No. 2	26.4	13.4	5.9
Box No. 3	29.1	15.0	6.3
Box No. 4	31.9	16.5	7.1
Case No. 1	24.8	12.6	10.6
Case No. 2	26.4	13.4	11.0
Case No. 3	29.1	15.0	11.8
Case No. 4	31.9	16.5	13.8
For oranges			
Box	24.4	11.8	5.1
Case No. 1	24.4	11.8	11.0
Case No. 2 (for bitter oranges)	29.1	15.0	11.8
Closed crate	19.3	13.0	7.1
For tangerines			
Box	23.6	11.8	3.5
Closed crate	19.3	13.0	4.7

Source: Report by the Consulate General at Palermo. These dimensions have been converted from those established in centimeters by Italian Ministerial Decree, November 21, 1937, Article 7.

Packing Costs

Labor. A great deal of labor is needed to prepare fruit for market, and it is only the low cost of labor which makes competitive prices possible.

A lemon packing crew usually consists of 9 persons, excluding management and accounting staff. The sorting and wrapping are commonly done by women, and the packing, lidding, and cartage are done by men, who are paid about twice as much as the women. Wages of a representative crew, at the average rates prevailing in 1949, would be as follows:

Job	Wage for 8-hour day	
	Lire	Dollars
1 unloader	1,200	2.09
1 lidder and boxmaker	1,200	2.09
1 labeler and strapper	1,200	2.09
1 packer	1,200	2.09
1 placer	600	1.04
2 wrappers and sizers @ 700 lire	1,400	2.43
2 sorters @ 700 lire	1,400	2.43
Labor cost per day	8,200	14.26
Management and accounting (estimated)	2,500	4.35
Total	10,700	18.61

Such a crew can pack about 80 boxes a day at which rate the labor cost of packing is 133.7 lire ($0.23) per box.

Materials. The cost of packaging material has seasonal variation depending upon the demand. In winter when export prices are higher, prices of box, paper, and other material will tend to increase, and low prices may be anticipated in the slack summertime. The price of a box, for example, may be as low as 100 lire in summer and as high as 250 lire in winter. In order to have accurate information on material packing costs, the following quotations were obtained September 1949 by the Office of the Consulate General at Palermo. These are actual quotations from suppliers and give in some detail the costs at that time.

	Lire	Dollars
Shook (for one box)	150	0.26
Wooden hoops (for binding boxes, 3 hoops to a box)	700 to 100	1.22
Box, made up	200	.35
Metal bands for export boxes, 2 to a box (wt. 100 grams)	230 per kilo	.18 per lb.
	(23 per box)	.04 per box
Seals for sealing export box	2.80 each	.005
Two for each box	5.60 per box	.01
Cost of sealing each box	7.0 per box	.01
Nails (14 x 27 mm. and 14 x 32 mm. (One package is enough for 200 boxes)	1,600 per 5 kilo	.25 per lb.
	320 per kilo	.25 per lb.
	8 per box	.01 per box
Paper wraps, plain (1,350 sheets 18 x 20 cm. per kilo)	185 per kilo	.15 per lb.
	46 per box (approx.)	.08
Paper wraps, printed (usually used on top layer only)	210-250 per kilo	.17-.20 per lb.
	52-62 per box (approx.)	.09-.11
Labor cost of manufacturing a box	20-24 per box	.03-.04

Range of packing costs. Since packaging material costs vary from season to season, and no single cost is representative, it is believed that packing costs can be most accurately presented in terms of indicated ranges. The high and low costs in Table 12 were estimated on the basis of the actual quotations from suppliers in September 1949 and on actual costs and estimates supplied by exporters.

Table 12.-Italy: Range of Costs of Packing Lemons, 1949

Item	High		Low	
	Lire	Dollars	Lire	Dollars
66-pound box				
Box	230	0.40	200	0.35
Paper wraps	80	0.14	65	.11
Sorting, wrapping, packing, inplant transportation, and general expenses	175	.30	85	.15
Nails	20	.04	10	.02
Shipping charges to port	50	.09	50	.09
Subtotal	555	0.97	410	0.72
Exporters commission 20 percent (estimated)	100	0.17	82	0.14
Total	655	1.14	492	0.86
76-pound box				
Estimated total (cost of 66-pound box plus 15 percent)		1.31		0.99

Domestic Marketing

The domestic price and supply situation usually depends on export conditions, since a major portion of Italian citrus production is exported. Fruit sold in domestic markets is prepared differently from that sold in export, and both lemons and oranges are often shipped loose in bulk. In the summer of 1949, when lemons were at a premium and buyers were paying 100 lire ($0.17) per kilo for fruit, lemons for northern Italian markets were being packed in baskets weighing approximately 40 pounds. This was a full wrapped pack and was decorated with colored shredded paper on top. A similar package is sometimes used for oranges in season.

The domestic price of Italian citrus varies greatly during the season. During the 1947-48 season the average monthly retail price of lemons at Milan varied from $0.05 to $0.10 per pound. The variation in the price of oranges was even greater, the Ovale variety ranged from a low of $0.07 per pound in January to as high as $0.30 per pound in September. (See Table 13.) In regard to these prices, however, it should be kept in mind that the high prices throughout the summer and fall are indicative of the very short supply of fruit reaching the market.

Domestic Consumption

There are no accurate statistics on the domestic consumption of fresh lemons, but it is believed that it increased during the war years. In Italy, as in other European citrus producing areas, the war prevented export, and large quantities of fruit were shipped to domestic markets which had hitherto been only lightly supplied. Higher wartime earnings also made possible the purchase of additional citrus supplies. The statistical department of the Bank of Sicily at Palermo, one of the leading sources of economic information on the Italian citrus industry, has estimated that national consumption of lemons ranges between 0.59 and 1.75 kilos per person (1.3 to 3.9 pounds). Based on a population of approximately 47.5 million in June 1949, domestic consumption of lemons is estimated to range between 755,250 and 831,250 quintals (2,190,821 boxes and 2,411,281 boxes).

Consumption by the Italian citrus processing industry must also be considered as a part of the domestic market. In 1918, 67 percent of lemon production was utilized in processing. Today's utilization, while smaller, is an outlet for approximately one-third of Italian lemon production.

Table 13.-Italy: Average Monthly Retail Prices of Sicilian Citrus at Milan

July 1947 through July 1948

Year and month	Oranges								Lemons		Tangerines	
	Tarocchi		Ovali		Blood		Comune					
	Lire per kilo	Cents per lb.	Lire per kilo	Cents per lb.	Lire per kilo	Cents per lb.	Lire per kilo	Cents per lb.	Lire per kilo	Cents per lb.	Lire per kilo	Cents per lb.
1947												
July	269	21	265	21			211	17	109	9		
August			326	26					132	10		
September			386	30					130	10		
October			357	28					117	9		
November	144	11	118	9			78	6	78	6	106	8
December	137	11	100	8	100	8	65	5	70	6	98	8
1948												
January	124	10	93	7	93	7	55	4	68	5	93	7
February	134	11	103	8	94	7	65	5	67	5	119	9
March	167	13	139	11	125	10	92	7	66	5	148	12
April	203	16	197	16	165	13	133	10	68	5	199	16
May			224	18	204	16	168	13	90	7		
June			219	17	202	16	177	14	86	7		
July			225	18			191	15	84	7		

Source: Citrus, Rivista della Camera Agrumaria, Messina, July-December 1948, p. 32.

Transportation

Transportation facilities are very different from those in the United States, and do not permit as careful handling of the fruit. Most fruit is taken from the grove to the packing house in donkey-drawn, two-wheeled, springless carts. Motorized truck transportation is utilized from the packing house to either railroad or ships for boxed citrus fruits. Fruits for processing, obtained either from the grove or from fresh fruit packing houses, are shipped in bulk to the larger processing plants in railroad cars. The fruit is piled 4 to 5 feet deep in the cars, which carry only 3 to 8 tons of fruit each.

Citrus fruits shipped either in boxes or in bulk to Paris, Switzerland, and Germany are transported by rail. If the origin of the shipment is Sicily, the rail cars are loaded in Sicily and carried by ferry over the Straits of Messina and then by rail through Italy and Switzerland . None of these rail cars have refrigeration; ventilation is provided by small mesh-enclosed openings at either end of the car, at both the top and the bottom In wintertime these ventilating spaces are kept closed, and the sides of the car are lined with paper and straw to protect the fruit against freezing. When bulk shipments are made, the top of the fruit is also covered with paper and straw for the same purpose.

The citrus growers can take advantage of the economy of sea transport, since all of the major citrus producing areas are near the coast. Boxed fruit is shipped by sea to the United Kingdom, Antwerp, Belgium, the Scandinavian countries, and New York. Bulk shipments are confined to markets which can be reached by rail.

Considering the type of transport used in and around the groves, it is obvious that only small quantities of fruit can be handled at one time. The small grove holdings and the rather prolonged harvesting season for lemons makes possible the transport of fruit in this manner.

Freight rates. Freight rates are important to the export of Italian citrus fruits. Converting the foreign currencies by legal and accepted rates of exchange, the existing freight rates in 1950 are quite high, compared with the United States freight rates for similar weights of fruit. For comparable distances, the sea freight rates are much less expensive than rail freight rates. For example, the freight rate from Naples to Liverpool is only $0.51 per 40 kilo or 88-pound box, while the freight rate via rail shipment from Messina to Brussels, Belgium, is $0.35 per kilo or 66-pound box.

The calculation of freight rates in Europe is a very complicated procedure. The Italian exporter shipping lemons from Sicily to Brussels encounters several different freight rates in several currencies. The freight from Sicily to the Italian border is paid in Italian lire; freight through Switzerland in Swiss francs; freight through France in French francs; and freight in Belgium in Belgian francs.

In Table 14, which gives freight rates for both rail and sea transportation, the rate has been indicated in the foreign currency as well as the conversion to United States dollars. This has been done in order that the rates may be used as comparison, even though there may be changes in the value of the foreign monetary units.

Table 14.-Italy: Freight Rates for Italian Citrus Fruit, March 1950

	Unit	Rate	
		Foreign currency 1/	U. S. dollars
RAIL SHIPMENT			
Messina to Paris			
Messina to Modane	Metric ton	3,933 lire	6.30
Modane to Paris	Metric ton	4,065 Fr. francs	11.64
Total	Metric ton		17.94
Total	Box		.57
Messina to Brussels			
Messina to Chiasso	Metric ton	3,805 lire	6.09
Chiasso to Basle (Switzerland)	Metric ton	43.70 Swiss francs	10.17
Basle to Bettembourg (Belgium)	Metric ton	2,374 Fr. francs	6.80
Bettembourg to Brussels	Metric ton	336 Belgian francs	6.72
Total	Metric ton		29.78
Total	Box		.95
Messina to Frankfurt			
Messina to Chiasso	Metric ton	3,756 lire	6.01
Chiasso to Frankfurt	Metric ton	70.70 Swiss francs	16.45
Total	Metric ton		22.46
Total	Box		.71
SEA SHIPMENT			
Naples or Palermo to London or Liverpool	40 kilos (88 pounds)	3s. 8d.	.51
Naples or Palermo to Gothenburg or Copenhagen	40 kilos (88 pounds)	6s. 0d.	.84
Naples or Palermo to New York			
Common stowage	Up to 30 kilos		.85
	Not over 45 kilos		1.15
	Over 45 kilos		1.34
	Half boxes		.58
Refrigerated stowage	Half boxes		1.15
	Up to 45 kilos		2.30
	Over 45 kilos		2.68

1/ Converting factors: 575 lire = $1.00, 320 French francs = $1.00, 4.30 Swiss francs = $1.00, 50.00 Belgian francs = $1.00, and £1 = $2.80.

Orchard Price of Italian Lemons

The relationship between the fruit buyer and the fruit seller in Italy is a very interesting one. Since a lemon grower usually sells only one bloom of fruit at a time, he has an opportunity to make several negotiations during the year. These negotiations may be heated but are a part of the citrus business enjoyed by the participants.

The price of lemons is determined primarily by export demand, and growers watch conditions very closely and try to sell to best advantage.

In 1949 at Palermo the average buying price in the winter season was 30 lire per kilo ($0.024 per pound). In summer, when supplies were short, the price was much higher, ranging from 50 to 60 lire per kilo ($0.04 to $0.06 per pound).

During 1948 and the first quarter of 1949 wholesale prices for oranges varied from 15 lire per kilo to as high as 75 lire per kilo. During the same period the price of lemons varied from slightly less than 10 lire per kilo to 80 lire per kilo. (See Table 15).

Table 16 gives 1948 and 1949 prices for lemons at the orchards on the Sorrento Peninsula near Naples. Owing to the colder climate and other conditions, the fruit usually ripens later in Sorrento than in most citrus areas of Sicily; it can therefore be sold to advantage when supplies from other areas are low.

During a normal shipping season there is a definite relationship between the price which a processor pays for fruit and that which an exporter pays for fruit. During the winter of 1949, when the price of lemons averaged approximately 30 lire per kilo, culled lemons were sold to processors by exporters for approximately 13 to 15 lire per kilo. According to this relationship, the processor normally buys culled lemons at approximately one-half the price the exporter pays for fruit containing all grades, including those suitable for export. When the export market is low, growers are willing to sell at low prices, and the processors tend to take advantage of such situations in order to build up supplies.

Table 15.-Italy: Wholesale Prices of Lemons and Oranges for 1948 and the First Quarter of 1949

Month and year	Average weighted price		Free market price			
			Minimum		Maximum	
	Lire per quintal 1/	Dollars per box of 76 pounds	Lire per quintal	Dollars per box of 76 pounds	Lire per quintal	Dollars per box of 76 pounds
	Lemons					
1948						
January	2,385	1.43	1,400	0.84	3,800	2.28
February	3,133	1.88	1,500	.90	6,500	3.90
March	3,063	1.84	1,800	1.08	2,800	1.68
April	3,956	2.37	2,000	1.20	7,000	4.20
May	4,387	2.63	2,000	1.20	8,000	4.80
June	3,104	1.86	2,000	1.20	7,000	4.20
July	3,971	2.38	2,000	1.20	6,800	4.08
August	3,456	2.07	985	.59	5,000	3.00
September	2,767	1.66	985	.59	4,000	2.40
October	3,305	1.98	2,350	1.41	4,000	2.40
November	2,240	1.34	1,135	.68	2,800	1.68
December	2,475	1.48	1,600	.96	3,000	1.80
Average	3,167	1.90				
1949						
January	2,759	1.65	1,275	0.76	3,200	1.92
February	3,017	1.81	1,900	1.14	6,000	3.60
March	2,586	1.55	1,800	1.08	4,000	2.40
	Oranges					
	Lire per quintal	Dollars per box of 70 pounds	Lire per quintal	Dollars per box of 70 pounds	Lire per quintal pounds	Dollars per box of 70 pounds
1948						
January	2,652	1.46	1,500	0.83	4,500	2.48
February	3,618	2.00	1,800	.99	4,500	2.48
March	5,823	3.22	-	-	-	-
April	-	-	-	-	-	-
May	-	-	-	-	-	-
June	-	-	-	-	-	-
July	-	-	-	-	-	-
August	-	-	-	-	-	-
September	-	-	-	-	-	-
October	-	-	-	-	-	-
November	-	-	-	-	-	-
December	3,690	2.04	3,000	1.66	5,000	2.76
1949						
January	4,557	2.52	3,000	1.66	7,000	3.87
February	4,632	2.56	3,150	1.74	7,500	4.14
March	4,620	2.55	3,900	2.15	5,000	2.76

1/ One quintal equals 100 kilos or 220.4 pounds.

Source: UNSEA Bulletin, Ministry of Agriculture and Forests, as furnished by the Agricultural Attache, American Embassy, Rome.

Table 16.-Italy: Lemon Prices at Amalfi, 1948-49

(Prices at place of production)

Month	Grade "Prima"				Grade "Seconda"			
	1948		1949		1948		1949	
	Dollars per box	Lire per quintal	Dollars per box	Lire per quintal	Dollars per box	Lire per quintal	Dollars per box	Lire per quintal
January	2.04	3,400	2.10	3,500	1.50	2,500	1.35	2,250
February	1.56	2,600	2.10	3,500	1.02	1,700	1.35	2,250
March	1.56	2,600	2.10	3,500	1.02	1,700	1.35	2,250
April	1.80	3,000	2.10	3,500	1.20	2,000	1.35	2,250
May	2.70	4,500	1.80	3,000	1.50	2,500	1.32	2,200
June	2.40	4,000	1.80	3,000	1.95	3,250	1.32	2,200
July	2.40	4,000	3.90	6,500	1.95	3,250	1.32	2,200
August	2.40	4,000	3.90	6,500	1.80	3,000	3.00	5,000
September	2.40	4,000	5.10	8,500	1.80	3,000	3.30	5,500
October	2.70	4,500	6.59	11,000	1.95	3,250	6.00	10,000
November	2.40	4,000	6.59	11,000	1.80	3,000	6.00	10,000
December	2.10	3,500	1/	1/	1.35	2,250	1/	1/

1/ Not available.
Source: Salerno Chamber of Commerce.

Export Marketing

Italy is the major source of lemons for Western Europe. Lemons have long been important to Italy as an export commodity by which to earn foreign exchange.

Lemon exports reached a peak in 1933 when nearly 8 million boxes were exported. Since that time Italian lemon exports followed a pattern of consistent decrease to 1945. From 1942 to 1946 war seriously interferred with all exports. Since 1946 lemon exports have increased; in 1948 slightly over 4 million boxes were exported, and in 1949 slightly over 5 million. This still was less than the exports of fruit in 1938. Decreasing lemon production in Sicily has been responsible for these lower exports, and in the next few years exports of lemons will probably continue at about the 1949 level. The production decrease has been due primarily to the killing of lemon orchards by the fungus disease, mal secco. Although resistant varieties, such as the Monachello, are being planted, this new planting has been insufficient to replace entirely destroyed orchards, and the resistant variety lemons do not produce as heavy crops as the older, susceptible comune variety.

Table 17.-Italy: Exports of Citrus Fruit, by Quantity and Value 1922-50

Year	Lemons				Oranges				Tangerines				Citrons			
	Quantity		Value		Quantity		Value		Quantity		Value		Quantity		Value	
	1,000 quintals	1,000 boxes	1,000 lire	1,000 dollars	1,000 quintals	1,000 boxes	1,000 lire	1,000 dollars	1,000 quintals	1,000 boxes	1,000 lire	1,000 dollars	1,000 quintals	1,000 boxes	1,000 lire	1,000 dollars
1922	1,359	3,942	-	-	869	2,737	184,040	8,753	-	-	-	-	-	-	-	-
1923	1,400	4,062	107,840	4,962	813	2,562	87,053	4,006	-	-	-	-	12	39	3,462	159
1924	1,758	5,099	130,500	5,687	1,234	3,886	169,939	7,406	-	-	-	-	14	44	5,909	258
1925	2,371	6,877	244,979	9,744	1,442	4,540	216,453	8,610	-	-	-	-	18	55	10,915	434
1926	2,352	6,823	346,786	13,488	1,357	4,273	333,194	12,959	-	-	-	-	13	41	7,941	309
1927	2,465	7,152	340,766	17,570	1,469	4,626	339,625	17,511	91	288	32,750	1,689	24	75	7,001	361
1928	2,218	6,435	349,480	18,373	736	2,318	123,678	6,502	58	183	13,934	733	22	68	5,965	314
1929	2,290	6,642	322,091	16,856	822	2,588	142,135	7,438	103	323	20,016	1,048	14	44	5,757	301
1930	2,697	7,824	287,865	15,077	1,203	3,789	152,716	7,998	121	382	22,177	1,161	28	88	5,405	283
1931	2,612	7,577	254,070	13,228	1,122	3,533	130,094	6,773	92	289	14,792	770	24	75	3,046	159
1932	2,444	7,089	251,511	12,891	547	1,724	66,084	3,387	68	214	8,546	438	16	52	2,520	129
1933	2,717	7,882	204,952	13,751	1,317	4,148	112,126	7,523	111	350	12,275	824	27	85	2,916	196
1934	2,496	7,241	189,015	16,183	825	2,598	78,126	6,689	72	226	7,780	666	32	100	3,024	259
1935	2,150	6,236	180,481	14,884	843	2,656	87,977	7,256	91	287	9,367	773	44	139	6,213	512
1936	1,794	5,204	152,468	11,117	767	2,416	80,097	5,840	92	291	12,246	893	32	100	5,021	366
1937	2,169	6,291	314,838	16,563	1,367	4,305	191,343	10,066	143	449	24,126	1,269	29	92	5,674	298
1938	2,022	5,865	295,970	15,570	1,331	4,192	209,273	11,009	170	535	29,467	1,550	33	104	5,539	291
1939	2,134	6,190	247,878	12,879	1,808	5,694	255,857	13,294	153	482	24,628	1,280	43	135	5,698	296
1940	1,963	5,695	254,863	12,847	1,428	4,499	232,559	11,723	109	343	24,202	1,220	32	101	5,005	252
1941	1,882	5,459	336,866	17,080	1,805	5,685	500,513	25,378	126	397	34,663	1,758	12	39	8,820	447
1942	1,517	4,401	401,858	20,375	779	2,452	325,639	16,511	76	239	26,269	1,332	23	72	9,399	477
1943	1/ 434	1/ 1,259	-	-	97	305	-	-	24	75	-	-	-	-	-	-
1944	1/ 268	1/ 777	-	-	68	214	-	-	1	-	-	-	-	-	-	-
1945	1/ 212	1/ 615	-	-	45	142	-	-	1	-	-	-	-	-	-	-
1946	1/ 480	1/ 1,393	-	-	176	554	-	-	105	331	-	-	3/	2	-	-
1947	893	2,591	3,115,710	8,101	778	2,452	3,216,230	8,362	323	1,018	1,714,025	4,456	9	10	27,375	71
1948	1,400	4,061	6,219,364	10,815	1,099	3,461	8,100,709	14,087	300	945	2,561,913	4,455	1	3	5,671	10
1949	1,768	5,129	9,427,032	16,394	1,419	4,469	9,205,922	16,009	364	1,146	3,097,013	5,386	4	12	42,080	73
1950	1,723	4,998	11,166,120	17,866	1,484	4,674	11,293,507	18,070	455	1,433	3,234,868	5,176	14	41	2/	2/

1/ Sicily only.
2/ Comparable value not available.
3/ Less than 500 quintals.

Source: Citrus Chamber of Commerce, Messina, and official sources.

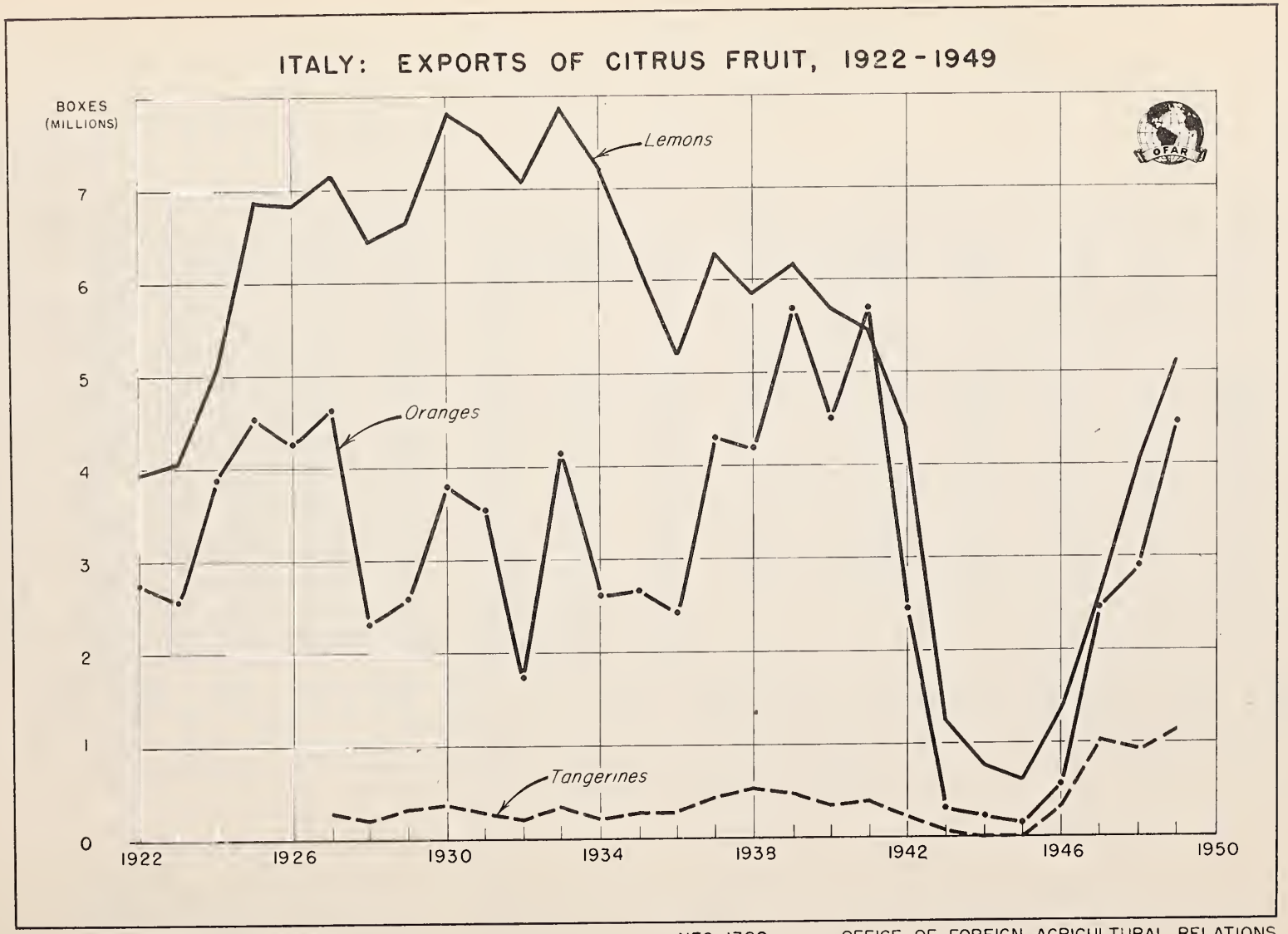

ITALY: EXPORTS OF CITRUS FRUIT, 1922-1949
BOXES (MILLIONS)
Lemons
Oranges
Tangerines
0
1
2
3
4
5
6
7
1922
1926
1930
1934
1938
1942
1946
1950
OFAR
U. S. DEPARTMENT OF AGRICULTURE
NEG. 1389
OFFICE OF FOREIGN AGRICULTURAL RELATIONS

Table 18.-Italy: Exports of Citrus Fruit, by Country of Destination, Monthly 1949

Country of destination	January	February	March	April	May	June	July	August	September	October	November	December
	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes
Oranges												
Belgium-Luxembourg	126,040	103,175	60,626	22,991	19,904	7,748	-	-	-	315	882	10,299
Austria	74,358	151,739	139,142	68,563	41,226	6,771	441	-	-	220	1,827	73,130
France	2,960	99,364	87,460	8,283	38,203	10,141	4,220	3,496	-	-	-	1,827
Germany	288,614	51,714	214,382	225,027	28,502	13,574	409	-	-	-	91,554	365,837
Sweden	43,053	137,473	152,936	69,193	630	409	-	-	-	-	12,472	99,364
Switzerland	161,881	202,351	155,739	219,799	101,884	23,243	4,913	724	-	-	2,740	78,389
Others	153,786	176,589	93,223	65,192	25,763	6,898	221	504	598	441	724	32,282
Total	850,692	922,405	903,508	679,048	256,112	68,784	10,204	4,724	598	976	110,199	661,128
Tangerines												
Belgium-Luxembourg	29,636	11,527	1,008	-	-	-	-	-	-	-	2,834	55,084
Germany	29,006	441	-	-	-	-	-	-	-	-	96,530	193,312
United Kingdom	266,190	150,574	23,400	2,268	-	-	-	-	-	-	4,504	05,823
Switzerland	28,061	3,023	945	126	-	-	-	-	-	-	3,559	97,002
Others	28,975	3,244	472	-	-	-	-	-	-	-	3,055	46,297
Total	381,868	168,809	25,825	2,394	-	-	-	-	-	-	110,482	457,518
Lemons												
Belgium-Luxembourg	36,434	27,964	11,574	29,414	22,481	39,567	16,680	16,186	9,225	21,437	40,437	14,823
Austria	12,386	37,913	38,291	48,327	17,637	47,022	7,397	15,403	9,225	15,867	37,912	32,344
Czechoslovakia	27,210	38,929	12,618	43,860	36,550	16,970	1,189	116	-	4,815	35,999	77,886
France	15,142	28,399	30,922	98,163	82,963	37,333	142,690	38,345	29,182	47,979	128,012	163,923
Germany	241,085	54,071	34,693	302,175	33,852	169,377	83,427	44,933	19,290	205,405	292,284	42,729
United Kingdom	25,266	92,912	101,499	38,203	72,114	69,561	32,837	21,250	23,177	78,669	130,652	51,054
Switzerland	8,905	10,820	16,680	8,238	10,501	15,606	16,303	20,451	17,869	18,043	27,209	22,916
Canada	41,278	38,812	20,277	9,573	28,138	73,245	22,046	1,740	-	35,129	14,359	15,374
United States	9,457	26,196	12,850	13,199	5,395	64,194	11,313	551	377	9,109	4,670	7,774
Others	51,779	78,205	44,730	27,963	28,543	35,477	21,523	8,966	4,873	31,009	58,653	69,039
Total	468,942	436,221	324,134	619,115	338,174	568,352	355,405	170,944	113,218	467,462	770,188	497,862

Source: Official sources.

Table 18a.-Italy: Exports of Citrus Fruit, by Country of Destination, Monthly 1950

Country of destination	January	February	March	April	May	June	July 1 to July 14	July 15 to August 31	September	October	November	December
	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes	Boxes
Oranges												
Austria	52,860	38,121	24,619	15,820	4,444	-	-	-	-	-	-	-
Belgium-Luxembourg	38,628	28,975	5,209	7,546	14,166	-	-	-	-	-	-	-
Germany	426,140	107,320	170,460	62,239	43,538	1,496	-	-	-	-	170,286	627,243
Netherlands	283	5,152	-	-	-	-	-	-	-	-	-	-
United Kingdom	-	1,575	-	-	-	-	-	-	-	-	-	-
Sweden	291,785	193,114	154,530	155,119	52,829	-	-	-	-	-	12,333	43,040
Switzerland	138,197	242,994	242,922	152,420	89,249	7,514	-	-	-	-	10,270	94,546
France	-	237,190	152,127	53,509	126,538	4,475	598	-	-	-	-	-
Czechoslovakia	-	13,004	4,658	10,267	72	-	-	-	-	-	-	-
Others	64,034	24,322	16,525	19,913	31,487	9,323	1,414	551	265	394	12,101	163,301
Total	1,011,927	891,767	771,050	476,833	362,323	22,808	2,012	551	265	394	204,990	928,130
Tangerines												
Belgium-Luxembourg	47,245	27,375	2,431	-	-	-	-	-	-	-	-	-
Germany	115,675	16,906	1,877	271	-	-	-	-	-	-	161,226	527,129
Netherlands	8,840	7,622	-	-	-	-	-	-	-	-	-	-
United Kingdom	54,000	56,872	33,271	6,380	-	-	-	-	-	-	-	-
Switzerland	64,667	17,385	324	16	-	-	-	-	-	-	-	-
France	-	26,065	5,974	-	-	-	-	-	-	-	-	-
Others	16,617	5,980	1,355	-	-	-	-	315	-	3	17,857	209,245
Total	307,044	158,205	45,232	6,667	-	-	-	315	-	3	179,083	736,374
Lemons												
Austria	28,613	19,836	38,705	23,270	23,467	17,503	5,616	11,969	-	-	-	-
Belgium-Luxembourg	24,137	19,293	34,876	15,551	38,917	22,353	10,016	-	-	-	-	-
Czechoslovakia	8,737	70,167	63,092	15,238	1,970	-	-	-	-	-	62,924	35,042
Germany	67,014	218,960	185,784	234,685	153,130	91,671	5,024	94,276	55,237	167,869	269,379	158,522
Netherlands	17,817	14,611	-	-	-	-	783	-	-	-	-	-
United Kingdom	75,130	89,872	124,194	23,697	64,972	8,201	4,050	-	-	43,970	65,242	91,723
Canada	50,218	12,027	1,888	1,233	14,382	783	-	-	-	-	-	-
United States	101,977	17,878	9,088	357	1,442	-	-	-	-	-	-	-
France	-	52,266	55,771	168,655	121,389	208,903	41,032	35,596	38,024	55,797	45,284	55,765
Switzerland	-	-	75,421	75,708	48,461	43,721	9,718	19,598	11,638	20,529	14,550	16,833
Others	73,693	25,307	37,516	60,968	40,277	38,488	4,995	20,527	31,339	125,041	112,049	83,818
Total	447,336	540,217	626,335	619,362	508,407	431,623	81,234	181,966	136,238	413,206	569,428	441,703
Cedri and Cedrati												
Germany	6,901	4,679	4,940	1,819	290	2,767	487	-	-	-	351	6,956
Norway	-	-	841	-	-	2,292	-	-	-	-	-	-
Others	218	1,990	583	1,325	165	1,421	-	-	-	-	435	145
Total	7,119	6,669	6,364	3,144	455	6,480	487	1,624	862	87	786	7,101
Other citrus	44	6	63	16	-	-	3	-	205	-	9	539

Before World War II, from 1930 to 1942, while lemon exports were declining, orange exports were increasing. In 1930 approximately 3.8 million boxes of oranges were exported, and by 1941 total exports had reached approximately 5 million boxes. Since 1945 exports have increased rapidly. Tangerines have always been of minor importance in Italian fruit exports, compared with either oranges or lemons. From 1946 to 1948 exports of tangerines were nearly double those of the prewar period. The increase in orange and tangerine exports is the result of increasing orange and tangerine production. This is due primarily to the increased plantings which have taken place during the past 15 years. In some cases, lemon orchards destroyed by mal secco have been replaced by oranges or tangerines which are resistant to the disease; in other cases, lemon groves have been interplanted with these varieties as a hedge against the destruction of lemon trees. Because of the increased acreage of oranges and tangerines, it seems likely that exports of these varieties will continue to increase in the next few years.

Seasonal Factors in the Export of Italian Citrus

The Italian orange is a winter fruit exported primarily from November to May. Small quantities are exported in July, August, and September, but these oranges are frequently either stored fruit or "off-bloom" fruit of inferior quality. The Italian oranges seen in a few retail shops in Switzerland in September 1949 had been imported in May and June and held in cold storage in Switzerland for sale in late summer.

The export of lemons also has a high seasonal character, but not so great as that of oranges. The heaviest export of Italian lemons takes place from October through June, with shipments continuing through July, August, and September at a rate of approximately one-third the volume of the winter and spring months in normal years. Since there are no large cold-storage facilities for lemons, in either Sicily or Italy, the supplies of fruit are limited to the lemons which ripen during the summer months. These may be produced by either a natural bloom or by the forced verdelli practice.

Changes in Italian Export Customers

The pattern of Italian citrus export trade was changed greatly by World War II, as is indicated by Table 19. Between 1937 and 1949, total orange exports increased by nearly 1 million boxes. In 1949, exports to England, Sweden, Switzerland, and Belgium were greater than in 1937 and to Western Germany were greater than the exports to all Germany in 1937.

These increased exports have more than made up for the loss of markets in Hungary, the Netherlands, Norway, Yugoslavia, Czechoslovakia, and Poland.

Germany and Switzerland are Italy's best customers for oranges, taking about half of total exports. Fruit is shipped to these markets by rail, in bulk, largely unwashed, unwrapped, and ungraded. This "orchard run" fruit is accepted in these markets. The fact that Italian oranges are not generally packed in a competitive export box reduces the export opportunities to countries such as Sweden, Belgium, and England. As increasing production makes the expansion of markets desirable, this packaging problem will probably become more important.

A somewhat different pattern has been followed in the export of Italian lemons. Lemon exports were over 1 million boxes less in 1949 than in 1937. Exports to Austria, Belgium, and France have increased since the war, but exports to other countries have declined or have been eliminated. Although exports to Western Germany in 1949 are not as great as the export to all Germany in 1937, this market has recovered to nearly prewar levels. While no 1949 lemon exports are indicated in Table 20 for Denmark, Norway, Sweden, and the Netherlands, these are undoubtedly a part of the item "others," for Italy did supply these markets in 1949.

Italy is Europe's most important supplier of lemons, and there is ample opportunity for market development in Western Europe as economic conditions improve.

Table 19.-Italy: Exports of Citrus Fruit, by Country of Destination, 1937-49

Country of destination	1937	1938	1946	1947	1948	1949
	1,000 boxes	1,000 boxes	1,000 boxes	1,000 boxes	1,000 boxes	1,000 boxes
Oranges and tangerines						
Austria	579	1/	12	86	222	557
Czechoslovakia	203	302	14	286	21	-
Denmark	139	220	-	-	99	-
France	401	195	88	-	810	256
Germany	1,443	1,616	1	10	109	1,599
United Kingdom	131	81	370	636	642	513
Poland & Danzig	161	288	-	9	1	-
Yugoslavia	90	89	-	-	-	-
Rumania	19	15	-	-	-	-
Sweden	385	557	271	625	512	516
Switzerland	558	616	311	1,114	968	1,084
Hungary	457	383	-	6	6	-
Eritrea	53	41	-	-	-	-
Belgium	26	140	27	144	784	452
Netherlands	7	60	-	-	2	-
Norway	-	-	168	280	4	-
Others	103	122	3	274	225	638
Total	4,755	4,725	1,265	3,470	4,405	5,615
Lemons						
Austria	267	-	67	64	285	320
Belgium	104	94	129	196	258	286
Czechoslovakia	450	410	238	504	402	296
Denmark	97	110	78	116	126	2/
France	560	581	92	322	487	343
Germany	1,824	2,220	2	13	284	1,523
United Kingdom	1,170	956	440	667	1,221	740
Greece	2	1	-	-	-	-
Netherlands	105	93	15	84	27	2/
Poland	368	402	-	29	77	-
Yugoslavia	105	115	3	-	-	-
Rumania	93	95	-	-	-	-
Sweden	74	81	45	70	-	2/
Switzerland	243	247	114	291	260	194
Turkey	29	22	-	-	-	-
Hungary	151	167	-	93	47	-
Argentina	47	43	-	-	-	-
Somaliland	147	51	-	-	-	-
United States	228	4	-	4	57	167
Canada	-	-	22	48	351	300
Norway	-	-	35	37	-	2/
Others	229	172	13	53	100	2/ 461
Total	6,293	5,864	1,293	2,591	4,062	5,130

1/ Not available. 2/ Exports of lemons to Denmark, Norway, and Sweden in 1949 are included in "Others."

Source: Official sources.

Trade Agreements 2/

The disruption of European economies by World War II, with the attendant instability of currencies and merchandise shortages, made it difficult to resume international trade. At the end of the war, Italy was faced with a new situation in the marketing of citrus products. Germany, one of its best prewar customers, was divided and trading made difficult in one section. It was therefore necessary to seek other European outlets for citrus and to direct the expenditure of earned foreign exchange into the purchase of commodities most necessary to the Italian economy. These problems have been resolved through trade agreements, which set the pattern and limits of trade.

Italy has made extensive use of trade agreements to dispose of its citrus crop. These agreements may be briefly summarized as follows:

Sweden. Italian trade with Sweden is carried on under a basic reciprocal trade agreement. As a part of this agreement, a list of Italian commodities to be exported to Sweden is made up, as is a list of Swedish commodities to be imported into Italy. Among the Italian exports to Sweden in a recent agreement are oranges to the amount of 12,500 metric tons and lemons to the amount of 3,000 metric tons. Other items on the list included fresh fruits and vegetables, rayon yarns and stockings, machine tools, and machinery. In return for these commodities, Italy imported from Sweden cellulose products including yarn and paper, fish, cast iron, machinery and equipment, and other items.

Denmark. Italy also made sales of citrus fruits to Denmark under a trade agreement which expired May 31, 1950, and included, among other Italian exports, cotton and rayon textiles, rice, chemical products, and automobiles. Lemons were listed to the value of 3,000,000 Danish kroners and oranges and tangerines to the value of 3,500,000 Danish kroners. In return for these products, Denmark exported to Italy primarily fish products, butter, seed potatoes, horses, poultry, and eggs. Limits of trade were established under the agreement, and in some instances they were in quantity by weight as in metric tons, or they were expressed in the value of a mutually acceptable currency, such as Danish crowns, in this case, or the limits were stipulated in both categories. In accordance with the agreement entered into, any commodity on one list was exchangeable for a commodity on the other list; therefore an importer from Italy would contact an exporter in Denmark, and, after they had made a mutually agreeable transaction, a full documentation of this would be forwarded to the appropriate exchange authority, and the necessary export and import permits would be executed in accordance with the trade agreement. After the necessary export and import permits had been obtained, and shipment of the goods had been made, a request for payment would be made to the exchange control office. In Italy the Italian exporter would be paid through a special account in Italian lire which would be opened

2/ From reports by ECA Consular Offices, and Embassies as of 1950.

with the Italian Exchange Office for each transaction and would be marked with the number given to each reciprocal transaction in Italy and in Denmark. After lemons, for example, had been shipped to Denmark the Italian exporter might not be paid in lire, immediately. The time at which he would be paid would depend upon the balance of the account between Italy and Denmark. Last year some Italian exporters of lemons had to wait as long as 6 months to obtain payment for the fruit shipped. This condition was brought about since Italian exports at that time were greater than the Danish imports into Italy. The delay was caused by the fact that the Italian exporter of lemons was paid from lire obtained from the sale of Danish goods in Italy.

Norway. Trade between Italy and Norway is under a trade agreement which was first approved August 1, 1946, and expired July 31, 1947. The agreement has twice been automatically extended, but lists of commodities in which trade may be carried on, with limits on each commodity was not in force in 1949.

The Netherlands. Italian trade with the Netherlands has also been under a trade agreement which among other items included the Italian export to the Netherlands of 500 metric tons of fresh fruit including citrus. Various other items were included, primarily textile materials, calculating machines, and automobiles. The Netherlands exports to Italy included cattle, plants, poultry, potatoes, and cocoa. Trade under these agreements is often very complicated. In the case of the Italian-Netherlands trade, the Netherlands importers found it difficult to make Italian purchases because the prices charged by the Italians were such that they were in conflict with the price controls in existence in the Netherlands. This agreement expired April 1, 1950. Trade under agreement has been by barter, with a provision for a money settlement of balances in florins at an exchange rate agreed upon between the two countries. A provision is also included for the settling of balances with the Netherlands East Indies in pounds sterling.

Belgium. Italy also negotiated a trade agreement with Belgium for the sale of citrus fruits. Among other items, it includes oranges, tangerines, and lemons to the amount of 26,000 metric tons. Other items on the list are wines, marble, leathers, glass, and tractors. Italian imports from Belgium under the trade agreement included eggs, fish, iron and steel, metal working machinery, and agricultural machinery. This agreement is on a clearing basis, and some barter is permitted on certain commodities. Trade under this agreement must be kept approximately in balance, and it provides that any existing balances at the end of the month must be settled in a mutually agreeable currency or in gold. In this case it was necessary to establish a mutually satisfactory unit of value, and it was agreed that payments through the clearing account were to be based upon the rate of exchange determined by the average rate between the daily rate of the export dollar and the average of the preceding 10-day period. In this manner the equities in existing accounts were stabilized in terms of the dollar.

Austria. Italy carries on trade with Austria under a trade agreement which has in it a new factor. Under this agreement the usual list of commodities is set forth, the Italian list of course including oranges and lemons. However, trade agreements are sometimes used to clear outstanding credit balances. In this case the value of Austrian exports to Italy is compensated for in two ways: 85 percent of the value will be compensated for by Italian exports to Austria; the remaining 15 percent of the value of Austrian exports to Italy shall be used to settle outstanding credits in a service account with the Italian exchange office. These credits are to be used in the settlement of existing accounts with Austria such as port expenses for transit through the port of Trieste.

Yugoslavia: Italian trade in citrus fruits with Yugoslavia is also carried out under a trade agreement. This provides for the Italian export of citrus fruit in the amount of 100,000 lire, together with other items, including paint, tires, electrical and telephone cables, and a variety of manufactured material. In return, Italy will import from Yugoslavia various types of raw material such as resinous sawn wood, railroad ties, coal, bauxite, opium, and other raw products. This agreement provides for clearing with two accounts in lire.

Poland. Italian trade with Poland is also carried on under a trade agreement with both clearing accounts kept in United States dollars. This agreement provides for a list of items on each side to be exchanged, the first item on the Italian list being citrus fruit to the amount of 6,000 metric tons. Other items on the list include various chemicals, and ores, The Polish exports to Italy include eggs, oats, barley, grain, and certain raw materials. A dollar account will be opened by the Italian exchange office in the name of the bank of Poland without interest, and the bank of Poland will open an account of dollars in Warsaw in the name of the Italian exchange office. The agreement stipulates maximum balances for these accounts. The Italian exports to Poland will be paid into the Polish account in dollars, whereby there will be mutual exchange credit between the two national organizations. The exchange rate applied to the clearing of balances incurred under the agreement was agreed upon as 50 percent of the monthly average lire exchange rate and 50 percent in United States dollars at the export dollar rate. The agreement will expire June 30, 1952.

Western Zone of Germany. Italian trade with Western Germany is carried out under a trade agreement which includes a provision for the export of citrus fruit. Other items on the list include hemp, rice, electrical machinery, textiles, and other products. The German imports to Italy will include coal as a major item, scrap, organic dyes, metal working machinery, porcelain, medicinals, and special machinery. This is a clearing type of agreement in terms of United States dollars. Many factors entering into trade may be incorporated within these agreements, and this German-Italian agreement provides for the protection of German patents in Italy. Under this agreement the use of dollars in actual payment would always be restricted to the settlement of remaining balance at the end of any agreement. Under this agreement lemons up to 20,000 metric tons, fruit pulp up to 100,000 metric tons, and tomato puree up to 5,000 metric tons were exported to Western Germany.

Soviet Zone of Germany. Italy has also negotiated a preliminary trade agreement with Soviet Zone in Germany to end the stalemate in trade between those two countries. Included in the Italian exports are citric acid, lemons, oranges, and textile products, and raw minerals, etc. Italy will import from Soviet Zone clay, seed, handicraft products, paper and printing machinery, ceramics, cameras, mercury, and other products. Under this preliminary agreement it is possible for members of the trade to enter into straight barter agreements. Apparently, an informal clearing arrangement has been made, invoicing being in terms of United States dollars.

Czechoslovakia. A similar type of agreement has been entered into between the Italian Government and Czechoslovakia. This agreement too is based entirely on barter transaction. The list of Italian exports under this agreement to Czechoslovakia includes essential oils, pectin, fruit juices, and other items such as roller bearings, motor vehicles and other manufactured goods. The Italian imports from Czechoslovakia will include chrome steel, malt, and other ceramic and manufactured items. This agreement is extended 3 months at a time. There are no formal lists of merchandise in which trade is to be carried on, and the settlement involves private compensation.

Hungary. Italian trade with Hungary is also carried out under a trade agreement which is of the clearing type. A list of Italian items to be exported includes lemons, oranges, and tangerines to the amount of 5,000 metric tons. Other items appearing on the Italian list are organic chemicals, pharmaceuticals, wheels and machine tools, sulphur and other chemicals, ball and roller bearings, and various other manufactured items. Items of the Italian imports include mostly food items and raw materials such as slaughter cattle, hogs, nicotine, bauxite, medicinal plants, pharmaceuticals, and grains. To settle credits arising out of transactions under this agreement, an account in lire is to be opened by the Italian exchange office in favor of the National Bank of Hungary. The account is credited with Hungarian imports and debited with Italian exports. There is a ceiling of 500,000,000 lire on the amount of trade that can be carried on under the agreement, and at the expiration of the agreement any account balance is to be settled in merchandise, dollars, or other acceptable currency. Under this agreement it is also possible for nationals of both countries to enter into barter transactions provided the permission of the authorities is first obtained.

France and the Territories of the French Franc Area. Italy has negotiated a trade agreement with France and the territories of the French franc area. The date of the agreement is July 1, 1949, and it expired June 30, 1950. This is a clearing agreement, with invoicing in French francs or Italian lire. The exchange applied is the average monthly lire French franc exchange rate stabilized in relation to dollar quotations. The agreement provides for trading in merchandise catalogued in four tables within the limits of the stabilized contingents. Among the commodities which Italy may export to France are 12,000 metric tons of lemons, 700 metric tons of citric acid, other items listed include essential oils and essences. The more important other items on the long list are heavy electrical equipment,

ball bearings, cotton yarns and fabrics; zinc ores, mercury, rice, almonds, and sulphur and nitrogenous fertilizers. The more important of the long list of commodities which France may export to Italy are food products, coal, iron ore, phosphate rock, potash fertilizer, superphosphates, dates, industrial diamonds, iron and steel scrap and various types of machinery.

Switzerland. Switzerland is an important Italian market for both oranges and lemons. Trade between the two countries is under a trade agreement which was negotiated November 1, 1947, and expired October 31, 1949; however, it is renewable for 1 year by tacit consent. There are no lists of merchandise in which trade may be carried on; however, a clearing account is established in Swiss francs, and settlement of balances may be made in the exchange agreed upon between the parties. Trade under the agreement is by barter.

Great Britain and Countries of the Sterling Area. Trade between Italy and the sterling area has been carried out under a trade agreement negotiated November 25, 1948. This agreement provides for settlement in pounds sterling for trade between Italy and the countries of the sterling area. Besides the United Kingdom, the agreement extends to Egypt, Ethiopia, Anglo-Egyptian Sudan, and Thailand. The exchange rate applied was the average monthly lira-dollar exchange rate multiplied by 403 (predevaluation). Under this agreement Italy supplies the United Kingdom with lemons.

The Italian trade agreements which have to do with citrus have been briefly outlined in order that the problems of marketing may be understood. It is obvious that the Italian lemon exporter must enter into complicated transactions in order to carry on his business. Exporting to countries where trade is by barter only, the exporter of lemons must be a seller and a buyer. This is usually accomplished by the exporter's making an arrangement with an Italian importer to take the goods obtained as compensation, at a stated lira price. In barter trading there are usually four parties involved, an importer and an exporter in each country.

The customary procedure in exporting lemons to a country where there is a clearing account under a trade agreement, first, to make the sale agreement; second, to apply for permission to export; third, to ship; fourth, to apply to the exchange control authority (operators of the clearing account) for payment. Payment is usually delayed and may require weeks or months depending on the trade balance between the two countries. The exporter will be able to estimate the time required for payment by consulting the published accounts of the clearing account status.

Payments are delayed because lemons exported from Italy are paid for in a foreign currency by the foreign importer. The importer pays through his bank to the clearing account, and this foreign currency then becomes available to an Italian importer, who wishes to buy goods in the foreign country. This Italian importer applies for permission to import a trade agreement item, and, when permission is granted, he pays for the merchandise in lire to the exchange control authority through his bank. It is these lire spent

by the Italian importer which then become available to the Italian lemon exporter. It is obvious that, if trade is unbalanced for a time, payments will be delayed. If importers are not importing, exporters cannot be paid for exports.

Italian lemon exporters find it necessary to borrow to carry them from the time of export to the time of payment. In 1949 the interest rate for such loans was reported to range from 8 to 12 percent.

It is this factor of delayed payment which probably makes exports to the United States attractive. If favorable dollar exchange rates or a certain portion of the earned dollar exchange were made available to Italian lemon exporters by the Italian Government there would be an increased incentive for the export of lemons to the United States. Either favorable lire exchange rates or a percentage of the export payment available to the exporter as free dollar exchange would be in the nature of a subsidy to the Italian exporter.

As trade is liberalized in Europe and currencies become stable, these trade barriers will be less serious; however, unrestricted trade is still a future prospect.

United States Imports of Italian Lemons

In 1949 the United States resumed the import of lemons from Italy. The principal shipments were received in February, March, June, July, and December, imports being greatest in June. A total of over 169,000 boxes was imported during 1949. (See Table 20).

In 1950, much larger shipments were received in January and February, the peak being in January when nearly 71,000 boxes were imported. Unlike 1949, imports declined in March, probably owing to the smaller supplies available in Italy and to a declining market for lemons in New York.

Table 20.--Lemons: United States Imports of Italian Lemons, by Months, 1949-50

Month	1949	1950
	Boxes	Boxes
January	11	70,295
February	12,910	63,499
March	36,734	10,520
April	5,115	2,607
May	5,513	239
June	59,747	2,636
July	25,990	967
August	2,059	0
September	0	0
October	0	0
November	2,495	0
December	18,458	276
Total	169,040	151,739

Source: United States Customs.

PROCESSING

The processing of citrus fruits, particularly lemons, has always been important to the Italian citrus industry. A large percentage of the Italian lemon production has been disposed of through processed products in the past, and the bergamot oranges, grown at Reggio, are used exclusively for processing purposes.

In the future the quantity of oranges and tangerines used for processing, may increase owing to the expanding production of these types; however, the quantity of lemons used in processing may decrease owing to the low production and the demand for fresh export lemons.

The importance of individual products has changed during the past 20 years. For instance, when the primary source of citric acid was citrus fruit, this product was a very important item in the list of processing products in Italy. However, with the development of other sources for this chemical, both the production and the price of this item have declined. Processors are consequently placing more emphasis on citrus juices.

Processing Plants

The largest installations of processing plants utilizing lemons primarily are located at Palermo and Messina. Small processing plants are located in other citrus areas in Sicily; however, the primary processing is done at the two cities mentioned. Processing plants are also located across the Straits of Messina near Reggio, where bergamot is a primary citrus variety for processing. It is characteristic of this district that the extraction of raw essential oils and the manufacture of some tartaric acid often take place at a small installation on or near the place of production. These raw products are then taken to Reggio where the oils are refined for export.

The Italian citrus processing plants may be roughly divided into two classifications. The first and most numerous type is the simple installation where raw essential lemon oils are extracted primarily by hand methods and orange juice is extracted by simple power-operated spindles. Most of the products from these plants are diverted to larger plants, where the oil is processed for export. However, the single-strength juice may be sold in casks with sulphur dioxide used as a preservative.

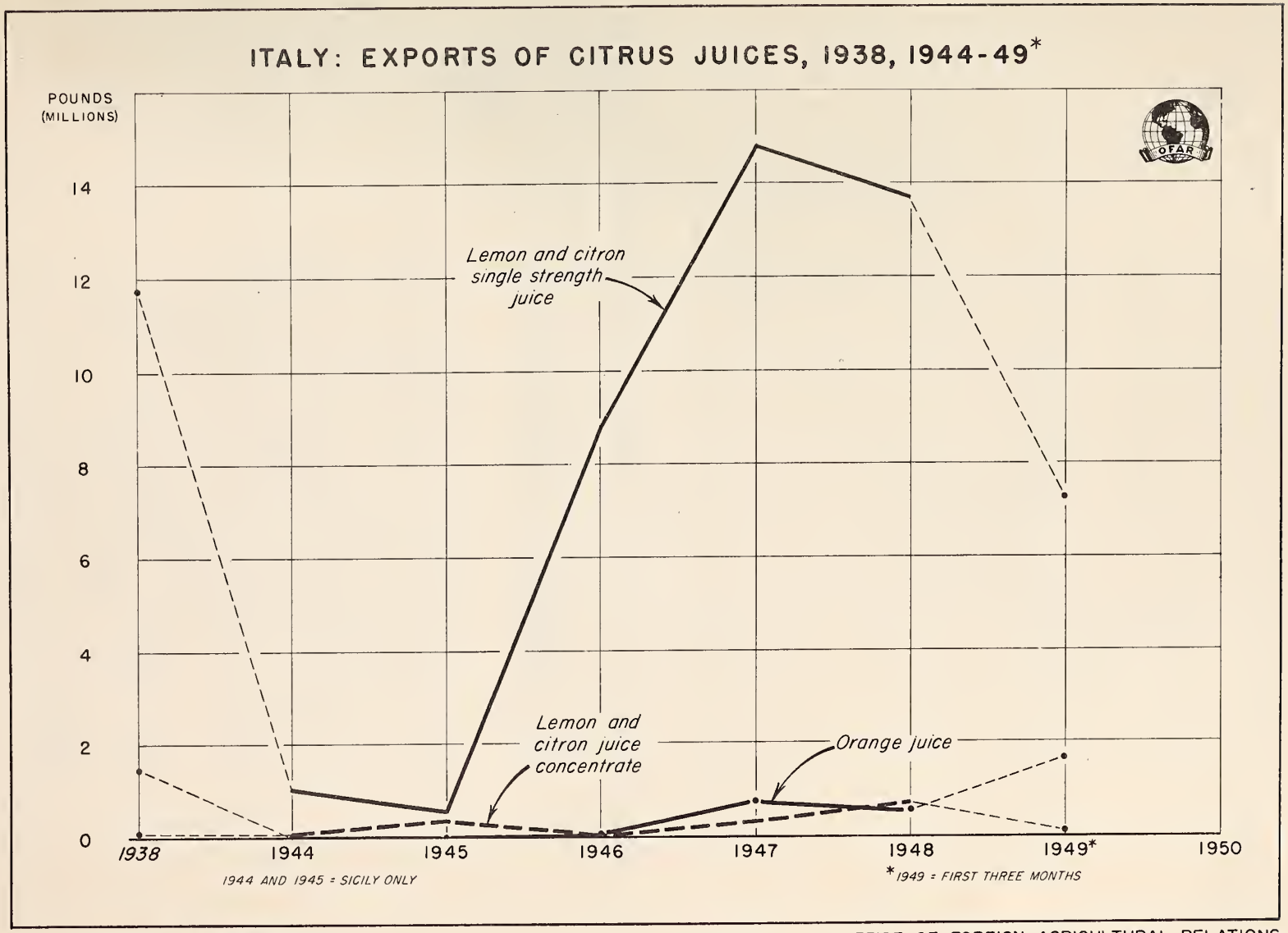
The second classification includes the large plants at Palermo and Messina, which are completely equipped to handle the extraction and concentration of juice and oils. These well-integrated plants are probably more accurately termed industrial installations, since they produce such a wide variety of products, including sulphuric acid and other heavy chemicals in addition to citrus products. The following list gives the principal products of one large Sicilian processor:

Table 21. - Italy: Exports of Processed Citrus Products, 1938, 1944-48, and First Quarter 1949

Product	1938	1944	1945	1946	1947	1948	Jan.-Mar. 1949
	100 pounds	100 pounds	100 pounds	100 pounds	100 pounds	100 pounds	100 pounds
Orange juice							
Italy 1/	14,780	2/	2/	326	7,392	5,637	3/16,695
Sicily	13,430	44	4	306	1,779	4,841	17,577
Lemon or crude citron juice							
Italy 1/	117,448	2/	2/	88,221	148,173	137,494	72,902
Sicily	117,366	10,051	5,586	86,068	141,229	136,848	72,769
Lemon or citron juice concentrate							
Italy 1/	690	2/	4/	203	3,025	7,041	763
Sicily	511	370	3,309	88	115	750	---
Citric acid							
Italy 1/	54,817	2/	2/	27,381	4,936	15,620	3/ 1,351
Sicily	56,105	12,236	1,254	23,521	3,514	15,450	1,380
Calcium citrate							
Italy 1/	---	2/	2/	---	---	2,599	1,706
Sicily	---	---	---	---	---	---	---
Orange essence (terpenes not removed)							
Italy 1/	707	2/	2/	1,122	452	284	95
Sicily	644	439	49	981	238	265	86
Lemon essence (terpenes not removed)							
Italy 1/	6,389	2/	2/	7,086	7,174	6,565	899
Sicily	5,924	5,381	2,518	7,092	6,698	4,594	597

1/ Including Sicily.
2/ Not available.
3/ Discrepancy probably due to incourrectly reported shipments between Sicily and Italy.
4/ Less than 100 pounds.

Source: Bank of Sicily.



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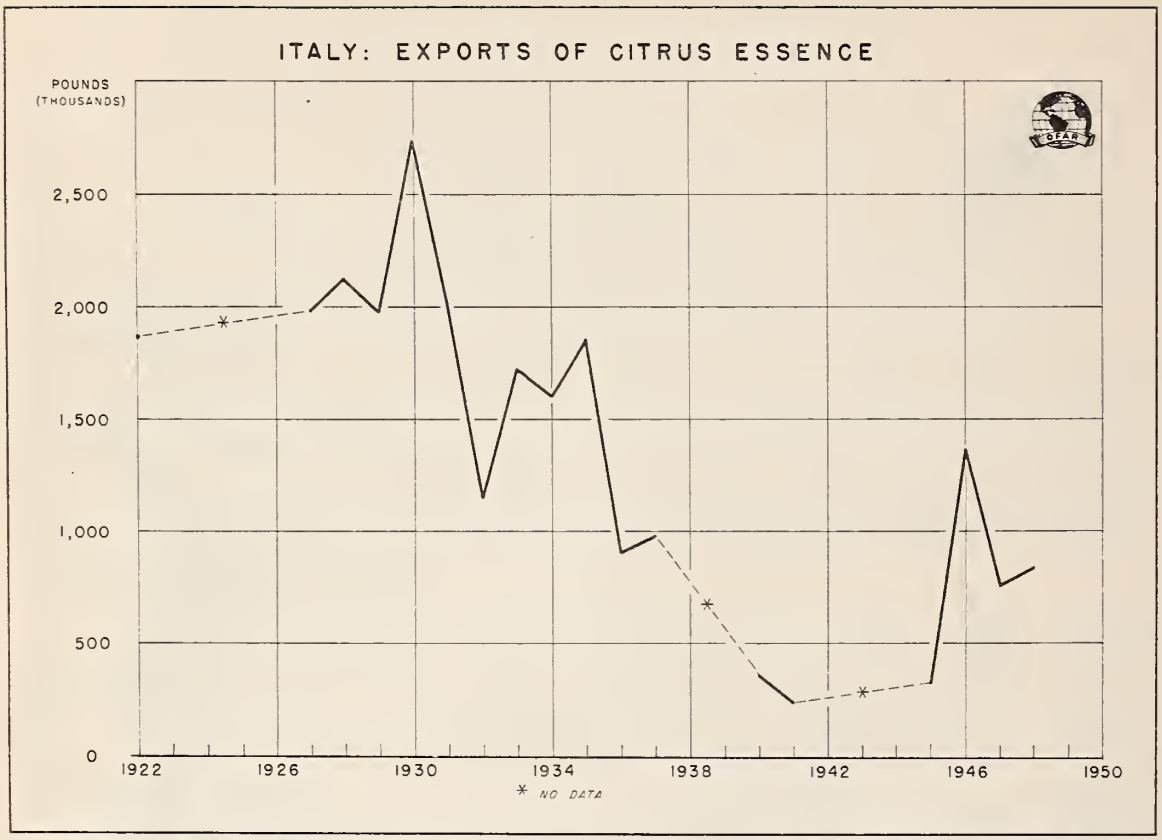

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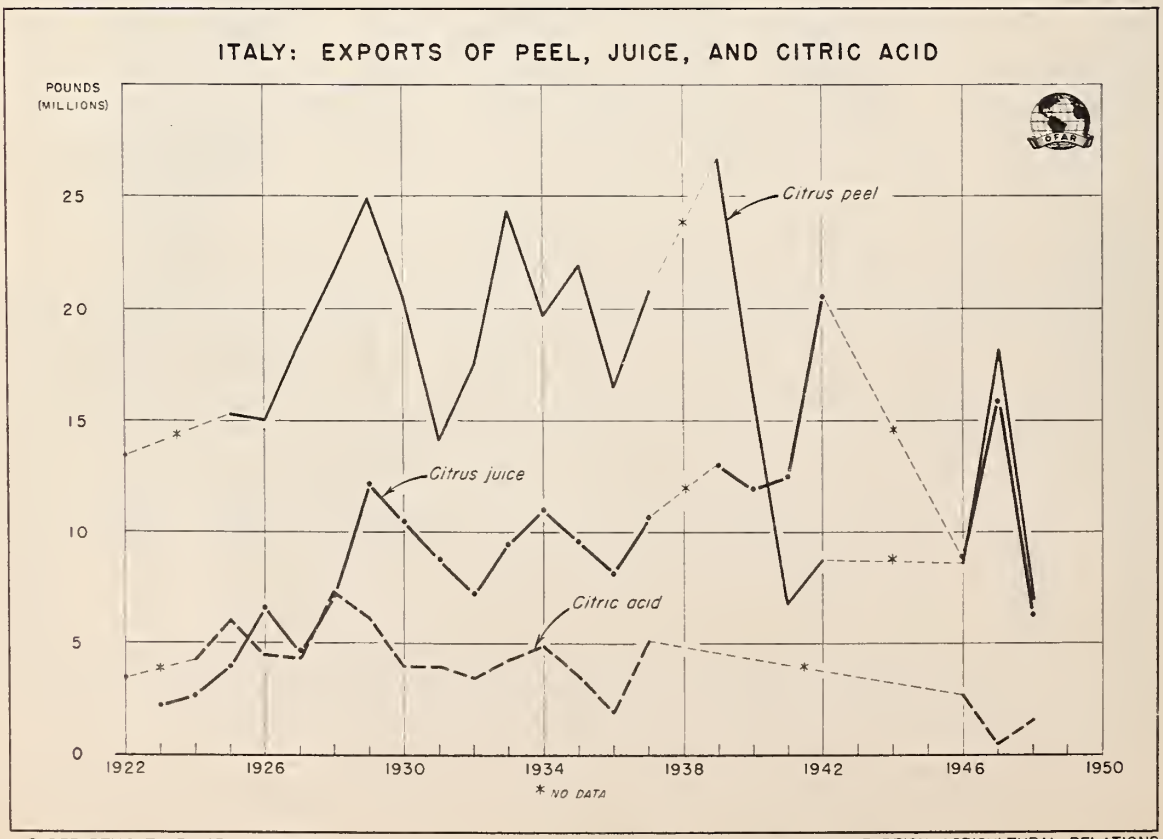

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Citric acid, hydrate and anhydrous (in granular form, crystals, and powder)
Tartaric acid
Cream of tartar
Essential oils of lemons, oranges, and tangerines (Extracted by both sponge and machine methods)
Essential oils of lemons, oranges and tangerines, terpenes and sesquiterpenses removed
Citrus juices, natural and concentrated
"Vitamin juices"
Citrus pectin
Grape juice, natural and concentrated
Acids, sulphuric, nitric, hydrochloric (in various concentrations)
Alcohol
Sulphuric ether
Sulphur dioxide for refrigerating equipment, wine making, and preserving citrus juice and pulp
Sulphite of calcium
Sulphate of soda
Extract of sumac, for tanning
Carbonized bones, for bleaching
Glue for furniture
Aromatic citrus pastes
Carbonate and oxide of magnesia

Processing Practices

There are several methods of extracting essential oils. Much of it is still done in the old manner, whereby the lemons are cut in two by hand, the fruit pulp is removed with a spoon-like knife, and the oil is expressed into a sponge by hand. The pulp is pressed to remove the juice. The extraction of essential oils from the peel does not hurt the rind, and it may be used as peel-in-brine.

In other more modern processing, the lemons are cut in half and juiced mechanically, the essential oils being extracted from the halves in another process. The extracted lemon juice may be sold as a single-strength product, but it is more commonly concentrated. In either case, it is kept by the addition of a preservative, usually sulphur dioxide. In one large plant visited, the lemon juice, both single-strength and concentrated, is stored in large wooden tanks, each of which contains about 5,000 gallons. These are open vessels in which the juice is stored, sometimes for months, before it is placed in barrels of approximately 50 imperial gallons for shipment to England to be utilized in the "squash" industry.

Table 22. - Italy: Exports of Citrus Essence, Peel, Juice, and Acid, 1922-37, 39-42, 45-48

Year	Citrus essence		Citrus peel		Citrus juice		Citrus acid	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	1,000 pounds	1,000 dollars	1,000 pounds	1,000 dollars	1,000 pounds	1,000 dollars	1,000 pounds	1,000 dollars
1922	1,865	864	13,370	187	---	---	3,480	1,390
1923	---	---	---	---	2,205	175	---	---
1924	---	---	---	---	2,665	187	4,256	1,233
1925	---	---	15,311	228	3,991	262	6,118	1,632
1926	---	---	15,002	233	6,609	365	4,544	1,265
1927	1,983	5,577	18,485	395	4,679	408	4,368	1,563
1928	2,127	6,519	21,554	513	7,207	319	7,358	2,752
1929	1,985	7,087	24,936	689	12,134	370	6,181	2,425
1930	2,739	4,124	20,420	315	10,492	251	4,005	1,502
1931	2,016	1,867	14,120	188	8,797	183	4,000	905
1932	1,151	1,078	17,409	303	7,228	153	3,487	495
1933	1,721	1,458	24,321	354	9,501	190	4,322	587
1934	1,605	1,668	19,685	394	11,029	262	4,914	741
1935	1,860	2,258	21,944	331	9,600	209	3,563	683
1936	910	1,786	16,501	409	8,125	197	1,895	377
1937	985	2,709	20,874	617	10,712	293	5,144	924
1939	---	---	26,681	---	12,999	---	---	---
1940	364	1,633	16,113	455	11,935	535	---	---
1941	240	1,237	6,886	319	12,514	870	---	---
1942	---	---	8,741	---	20,507	---	---	---
1945	330	---	---	---	---	---	---	---
1946	363	3,471	8,611	155	8,875	498	2,738	594
1947	760	2,080	18,170	543	15,859	624	523	416
1948	835	2,191	6,925	174	6,365	351	1,587	278

Source: Citrus Chamber of Commerce at Messina.

After the essential oils are extracted from the lemon, they are refined and concentrated, and it is not an uncommon practice for large purchasers to buy raw lemon oils from small operators, thus increasing the supply handled. The refined lemon oil is stored in a cool dark place, either a cave under the plant or a completely darkened warehouse with heavy stone or concrete walls. The conditions suitable for the storage of wine are similar to those used for storing lemon oil. The oil is stored in bulk in copper, tinlined retorts, which contain approximately 100 to 200 gallons each. As sales are made, the oil is placed in small tin containers for shipment to the consumer.

The large plants in Sicily at Palermo and Messina manufacture pectin, and both plants are expanding this part of their processing facilities. In addition, the plant at Messina refines essential oils of other than lemon.

Oranges are also processed. However, the emphasis is on juice and pulp 1/ rather than upon the essential oils.

Definitions of Processed Citrus for the European Market

Peel-in-brine. Peels in brine may be lemon, citron, orange, or grapefruit, and under this trade name the product contains no flesh of the fruit. The peel may be in halves, quarters, eighths, or diced pieces. When the peel is in large sections, halves or quarters, it is packed in barrels with each portion fitting the other in a circular fashion along the outline of the barrel.

Pulp. Beverage pulp consists of the broken and unbroken cells of the flesh of the fruit without peel. This material is obtained from the flesh of juiced fruit. (Pulp for jam manufacture contains peel.)

Puree. A puree consists of the juice and the pulp of fruit which has been ground so that all the pulp is in small particles and contains no whole cells.

Cream. Cream is a pulp product similar to puree. It contains juice and such fine particles of the fruit pulp as may be obtained when the seeds are removed from the juice residue.

Essential Oils

Essential oils are a very important product to the Italian processing industry. As has been stated above, the bergamot fruits are grown primarily for this purpose. The second most important source of essential oils is the Italian lemon. Processors state that lemon essential oil produced in the Messina district customarily contains about 4 percent citral and that the lemon oils produced at Palermo usually contain about 3 percent citral. It is a common practice in Italy to price lemon oils in accordance with their citral content, and oils ranging from 2½ percent to 4 percent citral may be purchased.

1/ Beverage pulp containing fruit cells and no peel.

For a comparison of the prices of the several essential oils f.o.b., Italian ports in February 1948, see Table 23.

The processors of lemon oil in Sicily have an advantage over those in California in that it is possible to extract oil by hand methods, such as by sponge, in order to obtain a very high-grade product. Also, since the lemons are brought to the plant fresh from the grove, they are in excellent condition for the extraction of essential oils.

Table 23. - Italy: Average Quotations on Essential Citrus Oils f.o.b., Italian Ports, February 1948

Product	Messina		Catania		Palermo		Reggio Cal	
	Lire per kilo	Dollars per lb.	Lire per kilo	Dollars per lb.	Lire per kilo	Dollars per lb.	Lire per kilo	Dollars per lb.
Lemon	3,264	2.57	3,312	2.61	2,994	2.36	3,535	2.79
Bitter orange	2,627	2.07	2,468	1.95	---		3,143	2.48
Sweet orange	4,268	3.37	4,299	3.39	---		3,535	2.79
Tangerine	6,688	5.28	6,943	5.48	---		5,828	4.60
Bergamot	4,800	3.79						
Pure neroli	90,000 to 100,000	71.00 to 78.89						
Commercial neroli	30,000 to 40,000	23.67 to 31.55						
Petit grain, bitter orange	7,000	5.52						
Petit grain, lemon	5,000 to 5,500	3.94 to 4.34						
Petit grain, bergamot	4,500 to 5,000	3.55 to 3.94						

Sophistication and adulteration. The process known as sophistication has long been a part of the essential oil industry. This is a process whereby the residual terpenes of the concentration of lemon oil are made into an adulterated product by the addition of lemon-grass citral. The resulting product is similar to pure lemon oil and may be sold as a substitute. Since this artificial product can be produced at far lower cost than pure lemon oil, it offers serious market competition.

In addition to the process of pure sophistication, old oil may be blended with new oil or with lemon terpene and lemon-grass citral. All of these processes tend to stretch the supplies of lemon oil available.

In order to help eliminate this situation, the experiment station at Reggio is required by law to test and certify all essential oils which are to be exported. In their test they certify an oil as commercial or non-commercial. After certification, the shipping containers are sealed to prevent adulteration of the tested product. It is entirely possible that some oils which are not entirely natural are certified "commercial," as the process of adulteration and sophistication is carried out by people who have had long experience in the perfume industry and are exceedingly capable in making a product which by physical test cannot be readily differentiated from the natural product.

In the interest of the establishment of an orderly world market in essential lemon oils, it would be highly desirable to establish standards by which natural oils could be differentiated from the sophisticated. From discussions with numerous producers and dealers in essential oils as well as the experiment station, it would seem that this cannot be done by physical testing; therefore, a complete analysis should first be made to determine physical characteristics, and then other qualitative tests should be applied. If a product passes both the physical test and the qualitative test, it may be assumed that it is natural oil.

The qualitative test would involve the sampling of the fragrance of the oil and the tasting of the product. The fragrance of essential oils may be tested by immersing a small piece of absorbent paper into the oil, then permitting this to dry for approximately 10 minutes, after which time differences in bouquet are more noticeable. An expert may determine by the bouquet not only the nature of the oil but quite often the district from which the oil was produced. It would be to the advantage of our commercial interests, both consumers and producers of lemon oils, to develop methods of testing which would assure a more accurate grade labeling of essential oils sold in the United States market.

(For a description of the methods of testing essential oils in Italy and Spain and the approach in these countries to the problem of determining sophistication, see Appendix 2.)

Citric Acid

Citric acid is still produced in Sicily and Italy from the pulp and peel of fruit from which the essential oils have been removed. Citric acid is produced in the form of crystals, granules, and powder. The price of calcium citrate and citric acid is controlled by the Government.

Citrus Juices

Orange and lemon juices are produced in Sicily and Italy by both hand and mechanical extraction. The production of these juices is increasing, as are the exports.

Most of the lemon and orange juice concentration equipment is at least 30 years old, but it is understood that a new concentrater soon will be installed at a plant in Messina. One plant at Messina is expanding its operations to other citrus producing areas and is establishing essential oil and citric acid plants in both Argentina and Brazil.

Most of the citrus juice extracted is placed in barrels: canned juice is usually sold in commercial size tins of 5 liters (5.3 quarts) rather than in consumer size packages. Fruit juice prepared for consumers is bottled; Italian processors believe this produces a higher grade product, since there is no reaction between the tin and fruit acids.

Four classes of orange and lemon juices are produced. The single-strength juices are available with pulp and without pulp. The product without pulp is a perfectly clear one without any particles of the fruit flesh. The concentrated juices are also available with or without pulp. The concentrate without pulp, while clear and without fruit particles, is darker than the single-strength juice without pulp. These juices may be considered as representative of the type of product which is at present available commercially and which is sold to the "squash" industry in Western Europe.

These products can all be shipped in paraffin-lined casks which are much cheaper than the tin containers necessary for the shipment and preservation of flash-pasteurized products. The type of container in which shipments can be made is an important factor in determining the type of product which will be produced. While flash-pasteurized products can be produced, it is likely that they will be a minor portion of citrus juice production for some time, due to the cost of the tin container.

Comparison of Italian and United States Juices

In visits to Italian citrus processing plants samples of juices were obtained. These were tested by the United States Department of Agriculture, and the results are shown in Tables 24 and 25.

There has been confusion in comparing the Sicilian and United States grades of citrus juice concentrates. The United States concentrate of 6:1 is not the same as the Sicilian grade understood to be a 6:1 concentrate. To clarify the comparison a tabulation of the measurement of the degree of concentration by means of specific gravity and the refraction index was published in Citrus (Jan.-March, 1948, Messina), together with a table comparing the United States and Sicilian orange and lemon concentrates. (See Tables 26 and 27.)

Table 24. - Bottled Lemon Products from Italy

Analysis category	Unit	Concentrated		Single strength	
		With pulp	Without pulp	With pulp	Without pulp
Date of analysis		January 5, 1950	January 5, 1950	January 5, 1950	January 5, 1951
Fluid measure	Milliliters	110	110	110	110
Density	Degrees brix	37.45°	34.3°	8.1°	6.95°
Anhydrous citric acid per 100 ml	Grams	44.8	30.1	6.48	5.18
Ascorbic acid per 100 ml	Milligrams	8.32	23.8	0.95	3.9
Color		Dark	Dark, clear	Bright	Clear
Flavor		Good	Good	Good	Fair
Ratio of soluble solids to citric acid		0.836:1	1.14:1	1.25:1	1.34:1
Sulphur dioxide per 1,000 ml. (P.P.M.)	Milligrams	4.98	10.27	Trace	4.43
U. S. grade		None comparable	None comparable	A or Fancy	None comparable

Tested by Standardization and Inspection Division, Fruit and Vegetable Branch, Production and Marketing Administration of the United States Department of Agriculture.

Table 25. - Bottled Orange Products from Italy

Analysis category	Unit	Concentrated		Single strength	
		With pulp	Without pulp	With pulp	Without pulp
Date of analysis		January 5, 1950	January 5, 1950	January 4, 1950	December 28, 1949
Fluid measure	Milliliters	110	110	110	110
Density	Degrees brix	56.3°	49.7°	11.2°	11.2°
Anhydrous citric acid per 100 ml	Grams	9.09	17.4	1.85	2.17
Ascorbic acid per 100 ml.	Milligrams	12.0	144.8	37.52	45.29
Color		Excellent	Clear, dark	Excellent	Clear
Flavor		Good	Fair, very pungent	Very poor	Pungent, offensive flavor of SO_2
Ratio of soluble solids to citric acid		6.2:1	3.5:1	6.6:1	5.14:1
Sulphur dioxide per 1,000 ml. (P.P.M.)	Milligrams	13.7	55.32	132.78	1673
U. S. grade		Probably off-grade	None comparable	D or Substandard	None comparable
Comment		Not sufficient volume to determine grade. Probably off-grade account of deficiency of ascorbic acid.		Grade account of high citric acid content, low ratio of solids to acid and poor flavor.	

Tested by Standardization and Inspection Division, Fruit and Vegetable Branch, Production and Marketing Administration of the United States Department of Agriculture.

Table 26. - The Specific Gravity and Refraction Index of Several Sicilian Orange and Lemon Juice Concentrates

Degree of Concentration	Lemons		Oranges	
	Specific gravity	Refraction index	Specific gravity	Refraction index
3	1.111 - 1.120	1.3681 - 1.3710	1.139 - 1.150	1.3816 - 1.3860
3-1/4	1.121 - 1.128	1.3711 - 1.3740	1.151 - 1.163	1.3861 - 1.3905
3-1/2	1.129 - 1.135	1.3741 - 1.3770	1.164 - 1.175	1.3906 - 1.3950
3-3/4	1.136 - 1.150	1.3771 - 1.3795	1.176 - 1.188	1.3951 - 1.3995
4	1.144 - 1.150	1.3796 - 1.3820	1.189 - 1.200	1.3996 - 1.4040
4-1/4	1.151 - 1.160	1.3821 - 1.3850	1.201 - 1.213	1.4041 - 1.4085
4-1/2	1.161 - 1.170	1.3851 - 1.3880	1.214 - 1.225	1.4086 - 1.4130
4-3/4	1.171 - 1.180	1.3881 - 1.3910	1.226 - 1.238	1.4131 - 1.4180
5	1.181 - 1.190	1.3911 - 1.3940	1.239 - 1.250	1.4181 - 1.4230
5-1/4	1.191 - 1.200	1.3941 - 1.3975	1.251 - 1.263	1.4231 - 1.4280
5-1/2	1.201 - 1.210	1.3976 - 1.4010	1.264 - 1.275	1.4281 - 1.4330
5-3/4	1.211 - 1.220	1.4011 - 1.4040	1.276 - 1.288	1.4331 - 1.4380
6	1.221 - 1.230	1.4041 - 1.4070	1.289 - 1.300	1.4381 - 1.4430
6-1/4	1.231 - 1.238	1.4071 - 1.4095	1.301 - 1.313	1.4431 - 1.4475
6-1/2	1.239 - 1.245	1.4096 - 1.4120	1.314 - 1.325	1.4476 - 1.4520
6-3/4	1.246 - 1.253	1.4121 - 1.4148	1.326 - 1.338	1.4521 - 1.4565
7	1.254 - 1.260	1.4149 - 1.4175	1.339 - 1.350	1.4566 - 1.4610
7-1/4	1.261 - 1.270	1.4176 - 1.4208	1.351 - 1.360	1.4611 - 1.4650
7-1/2	1.271 - 1.280	1.4209 - 1.4240	1.361 - 1.370	1.4651 - 1.4690
7-3/4	1.281 - 1.290	1.4241 - 1.4270	1.371 - 1.380	1.4691 - 1.4735
8	1.291 - 1.300	1.4271 - 1.4300	1.381 - 1.390	1.4736 - 1.4780

Source: Citrus, Revista Della Camera Agrumaria Messina, January-March 1948, p. 15.

Table 27. - A Comparison of United States and Sicilian Degrees of Citrus Juice Concentrate

Lemon		Orange	
United States concentrate	Sicilian concentrate	United States concentrate	Sicilian concentrate
3	2.4 - 2.5	3	2.9 - 3.0
4	3.0 - 3.2	4	3.8 - 4.0
5	3.7 - 3.9	5	4.6 - 4.9
6	4.4 - 4.7	6	5.4 - 5.8
7	4.9 - 5.4	7	6.2 - 6.6
8	5.5 - 5.9	8	6.8 - 7.3

Source: Citrus, Rivista Della Camera Agrumaria Messina, January-March, 1948, p. 15.

These tables are interesting as a method of determining the degree of concentration of citrus juices, and as comparison between Italian and United States degrees of concentration. Measurement of the degree of concentration of citrus has apparently been a problem in Italy, as is indicated by the following quotation. 2/

> Before the above table on measurement of concentration by specific gravity and the index of refraction was established, the determination of the degree of concentration of the juices of American origin according to the criterion used in Sicily gave rise to confusion; the values were invariably found to be much lower than those stated by the manufacturers. Today, however, everything is clear: on the basis of the dry extracts corresponding to the various indexes of refraction, and to the various densities, it proves that in the United States double concentrate, for example, means a volume of juice reduced to one-half to one-third of the original volume.
>
> As is known, we (the Italians) rate the degree of concentration of our juices according to the following criterion:
>
> For lemon juice, according to the ratio between the acidity expressed as citric acid monohydrate, concentrated and that of the natural juice from which it came, valued at 60 percent in weight; for orange juice, according to the ratio between the total sugars of the concentrated juice and those of the natural juice from which it came, valued at 60 percent in weight.

2/ Translated from: Citrus XX (1-2-3), Camera Agrumaria Messina, January-March 1948, page 15.

It is evident, however, that by increasing the degree of concentration, we increase the total dry residue and the ash of the double, triple, etc., according to whether it is a question of a double or triple concentrate; and this is because the weight of the natural juice is reduced to one-half or one-third.

Example: a lemon concentrate containing 360 grams of acidity per kilo, expressed as citric acid monohydrate, is a sextuple concentrate because $\frac{360}{60}=6$.

Pectin

Pectin is being produced from lemons in plants at Palermo and Messina.

According to statistics published by the Bank of Sicily, 422,000 pounds of pectin were shipped from Sicily in 1947 and 787,000 pounds in 1948. There is evidence of increasing interest in the production of pectin, and a new plant is said to have been recently constructed at Messina. An increase in production may be anticipated.

This is one of the most difficult citrus by-products to produce. The cost of alcohol makes it desirable to use the "alum method," but processors indicate that, while a satisfactory product can be made by the "alcohol method," considerable difficulty is being experienced with the "alum method."

Nonfruit Processed Products

Neroli, or orange-flower oil, is produced in Sicily. This product is produced by distilling the vapor obtained by boiling orange blossoms. Neroli is the oil on top of the product of distillation. Blossoms of the bitter orange are primarily used for this purpose, and in the spring a sheet is placed under the trees and the blossoms are shaken from the tree. These blossoms are sold to processing plants, and in 1949 the price ranged from 32 to 34 lire per kilo ($0.025 to $0.027 per pound) at the grove. This product is used in perfume.

Orange-flower water is produced in the same process as orange-flower oil or neroli and is the product of distillation remaining after the Neroli has been removed from the top. Orange-flower water is used as a medicinal and in perfume.

Petit grain is produced from the leaves of the bitter orange, lemon, and bergamot trees. It is the product obtained by distilling the vapor of boiled orange leaves. It is used in perfumery.

Cost of Fruit for Processing

The source from which Italian processors obtain their fruit depends upon the economic conditions at the time. When fresh fruit is being exported at satisfactory prices, most supplies of processing fruit consist of the culls from fresh fruit packing plants. When fresh fruit export prices are low, processors may purchase directly from the grove, or they may do so when a windstorm drops an excessive amount of fruit, making it unfit for export in the fresh form. The processors may also buy directly from the groves, competing with fresh fruit exporters when the price of essential oils is high, making possible the purchase of fruit for processing only. Therefore, the Italian processor and the fresh fruit buyer and exporter compete with one another for citrus supplies.

In 1949 a common buying price for fruit for processing was 12 to 15 lire per kilo. At a price of 15 lire per kilo, the purchase price was approximately $26.08 per short ton.

Both processors and fresh fruit exporters interviewed in Italy quoted several purchase prices for fruit to be utilized for processing. Following is a summary of four of the quotations made in 1949.

1. 15 lire per kilo was reported by most exporters.

2. 3,000 lire per "thousand" (1,040) lemons weighing approximately 120 kilos (265 pounds), or 25 lire per kilo.

3. 22 lire per kilo in January to 9 lire per kilo, average price 13 lire per kilo.

4. 16 to 20 lire per kilo.

Usually, about 20 percent of the fruit purchased is unfit for export or fresh shipment.

Outlook

The processing industry will continue to be of great importance to the Italian citrus industry. However, the nature of the products will probably change somewhat in the coming years. Certainly pectin will be among the more important products, as will juice products. While no flash-pasteurization equipment was seen, some is installed and it is likely that such equipment will come into some general use in the near future. Production of concentrated juices is likely to increase.

The varieties of oranges raised in Italy, with a large percentage of blood varieties, together with the presence of the Mediterranean fruit fly, would seem to limit the quantities of fruit which would be available and suitable for processing purposes. However, the growing production of orange may result in a considerable increase in the production of orange juice

products. The production of lemon juice products and pectin may increase to some considerable extent; however, in the next few years the total utilization of lemons for processing purposes will be smaller than in the past owing to the lower production and the demand for export lemons.

The fungus disease, mal secco, has had an effect upon the processing industry. The old comune lemon was a very acid fruit and had a high yield of essential peel oil. This was very desirable from the point of view of the lemon processor. Since many of the destroyed lemon groves have been replanted with the resistant varieties, such as Monachello, the yield of essential oils has been reduced. These mal secco resistant varieties are a less acid fruit and have a lower yield of essential oil, which is a handicap to the production of lemon oil.

Lemons available to the Italian processor are probably of better quality than those available to the California processor, since the fruit is taken to the processing plant almost immediately from the orchard. Since the fruit is not stored, the yield of oils is probably higher than is the case with California fruit. Due to the quality of the Italian product and the low labor rates, the Italian citrus industry can be expected to remain highly competitive in world markets as regards essential oil products. They will not be as competitive in juice products, since these lend themselves to mechanization, which can overcome the advantage of low labor costs.

SOME HISTORICAL COMPARISONS

In 1927, Edwin Smith, Marketing Specialist in Fruits and Vegetables, United States Department of Agriculture, visited the Italian citrus area and wrote a report upon his findings. It is very interesting to compare the statements made in Mr. Smith's report on the Sicilian lemon industry with conditions as they existed in 1949, or 22 years later. During this time the industry changed to some extent, and the production of lemons decreased, primarily due to the destruction of groves by mal secco. The industry has further changed owing to the decline of the formerly important by-product, citric acid. By 1949 citric acid was a relatively minor by-product of the Italian lemon industry, and other new products, such as pectin and orange and lemon juice products, were being produced in increasing quantities.

In the period since Mr. Smith's report there has been little change in either the methods of citrus production or the method of packing fresh lemons.

Mr. Smith made some excellent cost studies on the production of lemons in 1927, and, according to his computations at that time, lemons were being produced at an average price of 15.45 lire per box or $0.77 per box at the orchard, unpacked. This compares with a cost of production as calculated in 1949 from $0.63 to $1.05 per box.

Mr. Smith also made some computations regarding the marketing of lemons in New York, and the costs at that time are an interesting comparison with the cost of shipping Italian lemons to New York today (see tabulation, page 67.

For marketing lemons in New York the following costs were involved in 1927: 1/

Item	Dollars per box
F.O.B. cost of lemons	1.36
Margin to exporter	.25
Insurance, banking and wharfage	.02
Freight, Palermo to New York at 2s.7d. less 4d	.54
United States tariff at 2 cents per pound	1.46
Labor, New York Fruit Exchange for drawing and displaying samples in auction room	.02
Inspection by the New York Fruit Exchange	.00¼
Cartage of samples, cooperage, etc. (estimated)	.02
Importer's commission, 3%) Auction commission, 3%) 6%	.229
New York Auction selling price	3.90

1/ Source: Edwin Smith, The Sicilian Lemon Industry, U.S. Department of Agriculture, June 30, 1927.

The information contained in Mr. Smith's report, together with information obtained in Sicily and Italy in 1949 and information given in L' Italia Agruiala, has been used as a basis for the comparison of a few of the cost factors in the Italian citrus industry from 1912 to 1949 (Table 28). An examination of this table will show that the dollar converted rate of wages has approximately doubled in that period, and that the general tendency has been for all costs to increase. Probably the most notable thing is the effect which inflation has had upon costs in terms of lire. This is an excellent example of the effect of inflation on the economy of a country. Wages since 1912 have increased from $2\frac{1}{2}$ lire per day to 600 lire per day, and yet the dollar value of these wages has only increased from 48 cents per day to $1.04 per day. In terms of purchasing power, there has actually been a reduction in wages over this period.

During this 37-year period there has been inflation in currency in Italy, but it is remarkable how the dollar value of costs has remained relatively stable. It will be noted that taxes have increased considerably during this period; even in dollar value, taxes are approximately three times those in former years. Owing to the necessity of large Government expenditures, high taxation may be expected to continue.

Table 28. - A Historical Comparison of Some Cost Factors in the Italian Citrus Industry

Item	1912-13 1/		1922-23 2/		1926-27 3/		1938 4/		1949 5/	
	Lire	Dollars	Lire	Dollars	Lire	Dollars	Lire	Dollars	Lire	Dollars
Wages, per day										
Cultural labor	2.50	0.48	11.00	0.52	16-18	0.80-0.90	10-12	0.53-0.63	600-700	1.04-1.22
Packers and box makers	-	-	-	-	21.30-23	1.06-1.15	-	-	1,200	2.09
Sorters and wrappers	-	-	-	-	7.10-9	0.36-0.45	-	-	600-700	1.04-1.22
Taxes										
Per hectare	150	-	750	-	750	-	500-800	-	25,000-70,000	-
Per acre	-	11.72	-	14.45	-	15.18	-	10.65-17.03	-	17.59-49.26
Manure, per basket										
Per 20 kilos	.75	-	3.00	-	2.25	-	.40	-	40	-
Per 44 pounds	-	.14	-	.14	-	.11	-	.02	-	.07
Sulphate of Ammoria										
Per kilo	-	-	-	-	-	-	.93	-	50	-
Per pound	-	-	-	-	-	-	-	.02	-	.04
Pest control, treatment per tree	-	-	-	-	-	-	3-4	.16-.21	130-140	.23-.24
Box, shipping	-	-	5.00	.24	5.00	.25	-	-	200	.35

1/ Source: Edwin Smith, The Sicilian Lemon Industry. Converted at 5.18 lire to the dollar.
2/ Source: Edwin Smith, The Sicilian Lemon Industry. Converted at 21.00 lire to the dollar.
3/ Source: Edwin Smith, The Sicilian Lemon Industry. Converted at 20.00 lire to the dollar.
4/ Source: L'Italia Agruiala, September 1949, page 482. Converted at 19.01 lire to the dollar.
5/ Source: L'Italia Agruiala, September 1949, page 482. Converted at 575.00 lire to the dollar.

CONCLUSIONS

The citrus industry of Italy is undergoing a fundamental change which will influence the character of its production in forthcoming years. The fungus disease, mal secco, will probably continue to destroy lemon groves and thus reduce production. As this destroyed lemon acreage is replaced by mal secco resistant varieties, such as the monachello, the lemon processing industry will be affected. Since these resistant variety lemons are less acid and have less essential oil in the peel, the production of natural lemon oil will tend to decline in Sicily and Italy. Since both tangerines and oranges are being planted in mal secco destroyed groves or are being interplanted with lemons, the production of both of these citrus varieties may be expected to increase in the next 5 years. It may be estimated that by 1956 the production of oranges and tangerines will increase to approximately 25 percent above present production levels. It would seem likely that the production of lemons will remain about the same, as the new lemon acreage coming into production each year about equals the acreage destroyed by mal secco.

Due to a modernizing program of the processing industry, the production of such by-products as pectin may be expected to increase in the future.

The combined factors of high yield per acre and reasonable labor costs will tend to keep Italy in an extremely competitive position for both oranges and lemons in Western European markets.

The reopening of European markets, particularly Western Germany, has solved Italy's immediate problem of export markets for citrus, but as the production of oranges and tangerines increases, export problems may arise for these two varieties. The restricted production of lemons combined with the reopening of European markets should enable Italy to find satisfactory European markets for lemons, and exports to the United States may not be continued.

Appendix 1

CONVERSION RATES FOR ITALIAN LIRE, 1913-49

Year	Cents per lira	Year	Cents per lira
1913	18.9977	1932	5.1253
1914	19.2495	1933	6.7094
1915	16.5287	1934	8.5617
1916	15.2674	1935	8.2471
1917	13.3181	1936	7.2916
1918	12.7196	1937	5.2607
1919	11.3690	1938	5.2605
1920	4.9700	1939	5.1959
1921	4.2936	1940	5.0407
1922	4.7559	1941	5.0703
1923	4.6016	1942 1/	5.0703
1924	4.3580	1943 2/	1.0000
1925	3.9776	1944 2/	1.0000
1926	3.8894	1945 2/	1.0000
1927	5.1560	1946	0.4000
1928	5.2571	1947	0.2600
1929	5.2334	1948	0.1739
1930	5.2374	1949	0.1739
1931	5.2063		

1/ Same as 1941 because of war.

2/ Military rate.

Source: 1913-1941 from Banking and Monetary Statistics; 1942-1949 from telephone conversations with Federal Reserve.

Appendix 2

ANALYSIS OF LEMON OILS 1/

This kind of essence is a typically Italian product and, although it is manufactured in Spain and the United States, it is far from being as important in those countries as in Italy.

As in the case essence of orange and the other citrus essences, its chemical composition and physical characteristics are related to the extraction procedure used. It is understood that a "sponge" essence and a distilled essence cannot be confused. However, the data which we offer below correspond to the type of essence ordinarily obtained by the systems used. The essences obtained by the various procedures in which water is employed for their removal generally have a lower density than others, since the water dissolves some of the constituents contained in the essence. Those obtained by "sponge" or by the Ajon machine have a yellowish color, while those extracted by the machines which handle the entire fruit are more greenish.

From 92 to 94 percent of the essence of lemon is composed of terpenes and sesquiterpenes, and the remainder, of oxygenated substances. Among the terpenes, the most abundant is limonene, which is widely dominant over the others; camphene and terpinene are also found in small quantities. The sesquiterpenes, bisabolene and cadinene, have been identified. According to Schimmel, pinene exists only in very small traces.

The oxygenated substances, in proportions of 6 to 8 percent, are largely composed of citral, which is the characteristic compound of this essence, and whose analysis is indispensable for cataloguing it among types and qualities adopted by the trade. The citral may fluctuate between 3.80 and 5.6 percent of the total weight of the essence. Linalool and geraniol have been found among the alcohols. In addition to the citral, small quantities of octyl and nonyl aldehydes have been identified. Acetic, capric, and caprylic acids are present. The esters appear in proportions varying from 1.20 to 1.75 percent and among them we find the linalyl and geranyl acetates and traces of methyl anthranilate. The only lactone identified is citropten. When the essence remains at rest for a long time, this compound is deposited in the bottom, in the form of a yellowish wax.

In general terms, the same procedure that we have already indicated for essence of orange is followed in making the analysis. Adulterations with terpenes and distilled essences are also common here, and for this reason we are going to indicate some of the details.

1/ Translated from: Alejandro Reig Feliu, Essencias de la Corteza del Fruto de los Agrios. Su Origen, Extraccion, Composicion y Analisis Fisicoquimico (Citrus peel essences. Their origin, extraction, composition, and physical and chemical analysis), Spain, Instituto Nacional de Investigaciones Agronomicas. Centro de las Cuencas del Jucal y del Turia, Estacion Naranjera de Levante, Book No. 66, December 1945.

The physical properties of essence of lemon are:

Density at 15 degrees: from 0.858 to 0.861
Rotatory power at 20 degrees: between 59 and 67 degrees

Fixed residue: the essences obtained by "sponge" give a residue of between 2.1 and 4 percent, while those extracted by machine may run as high as 6.5 percent.

That which dissolves in 7 times its volume of 90° alcohol is an index of good essence, although insufficient to use as the basis for a conclusive statement.

The rotatory power is one of the physical properties which is capable of accrediting the quality of the essence with the most speed and certainty. Now then the rotatory power of itself cannot supply the conclusion since, for example, if to the essence a quantity of essence of turpentine or terpenes of lemon be added, which we already know will decrease the normal rotatory power, it will be sufficient to add a calculated quantity of essence of orange adequate to neutralize the decrease in virtue of its high rotatory power. For this reason, it is necessary to combine this analysis with fractional distillation, the effect of which has been studied by Soldaini and Berte, and by Schimmel.

Soldaini and Berte Method. This consists of placing 20 cc. of the essence in a fractional distillation ball, provided with a thermometer, and distilling slowly at normal pressure. The first 10 cc. of the distillate are collected in a graduated tube and carried to the polarimeter, where it rotatory power is fixed, after having made the corresponding corrections for temperature. The rotatory power of this distillate must not be higher than that obtained directly from the essence in a figure included between 1° 30' and 3°. If the difference is greater, the presence of terpenes and fixed substances is deduced. If it is lower, it is a case of adulteration with essence of turpentine.

Schimmel method. 50 cc. of essence is placed in the large bulb of a Landemburg three-bulb, and 5 cc., or 10 percent of the essence is distilled, instead of 50 percent as shown in the previous method. This is collected in a graduated tube, filtered, and then observed in the polarimeter, in a 2 cm. tube. The rotatory power obtained is multiplied by 5; this result is subtracted from the figure representing the direct rotatory power of the essence. If the difference is greater than 5°, the presence of adulterants is indicated. To avoid confusion, we want to explain that the direct rotatory power is obtained by observing the essence directly in a 10 cm. tube at a temperature of 20°.

Below we offer a summary of the work done by Schimmel to discover adulterations in essence of lemon through the analysis of the direct rotatory power and of the first 10 percent of the distillate:

ESSENCE OF LEMON	Rotatory power	Rotatory power 10% distillate	Difference
90% of essence of lemon	61°52'	58°55'	2°57'
10% of 71% of essence of orange; mixture mixed with 29% of essence of turpentine	61°45'	54°28'	7°17'
A. - French			
90% of essence of lemon 10% of 60% of essence of orange; mixture mixed with 40% of essence of turpentine	61°42'	56°52'	4°50'
B. - American			
80% of essence of lemon 20% of mixture A	61°26'	49°50'	11°36'
80% of essence of lemon 20% of mixture B	61°35'	55°14'	7°21'

The rotatory power is always considered as referring to 20° of temperature. Notable differences can be observed which confirm the value of the method.

Determination of the citral. We have already indicated above that the percentage of citral contained in the essence qualifies it, and serves as a basis for commercial quotation; hence a knowledge of the most customary analysis procedures is of interest.

Kleber-Schimmel method. This is based on the fact that phenylhydrazine can be titrated exactly by means of hydrochloric acid, utilizing diethyl orange as an indicator; the phenylhydrazine, with the aldehydes, forms hydrazone, which has a neutral reaction to the indicator referred to.

Exactly 2 cc. of essence is weighed and mixed with 10 cc. of a 2% alcoholic solution of pure phenylhydrazine. This mixture is allowed to stand for one hour in a 50 cc. flask with a ground glass stopper; after which 20 cc. of one-tenth normal solution of hydrochloric acid is added, and slightly agitated. 10 cc. of benzol are now added, shaken energetically, and then the mixture is poured into a separating funnel. After standing a short time, the acid layer is separated and filtered. To

20 cc. of this filtered liquid are added 10 drops of diethyl orange solution (0.5 per 1,000), and the solution is titrated with a one-tenth normal solution of potash until a yellow color is clearly seen. The number of cubic centimeters of one-tenth normal potash needed to titrate 30 cc. of filtrate is then calculated. To check the titration of the phenylhydrazine solution, a test is made without essence.

If, for the 30 cc. of filtrate, there is a consumption a of one-tenth normal potash and, for the test without essence, there is a consumption b, the quantity a - b is equivalent to the quantity of citral contained in the p grams of the essence weighed. And since 1 cc of one-tenth normal potash corresponds to 0.0152 gr. of citral, the percentage of citral in the essence is established by the formula:

$$\frac{(a - b)\ 1.52}{p}$$

Romeo method. This author has proved that when the citral is kept in contact with a solution of neutral sulfite and acid sulfite of sodium and potassium, a trisulfonic derivative of the citral is formed, according to the equation:

$$C_9H_{15}CHO + 2Na_2SO_3 + NaHSO_3 + 2H_2O = 2NaOH + C_9H_{17}(SO_3Na)_2CHOHSO_3Na$$

The soda produced and the sodium bisulfite react:

$$2NaOH + 2NaHSO_3 = 2H_2O + 2Na_2SO_3$$

As a consequence of all that, it is deduced that one molecule of citral is neutralized by three molecules of bisulfite, which corresponds to three equivalent acids. Then titrating the acidity of the same volume of sulfite and bisulfite before and after the reaction with the citral, the exact amount of the citral absorbed in the reaction is obtained.

The description of the procedure is as follows: 1,000 cc. of water and 400 grams of crystallized sodium sulfite are introduced into a 1,500 cc. bulb. The sodium sulfite dissolves in this amount of water, some 160 cc. of bisulfite are added, a sufficient quantity established to acqire an acidity capable of neutralizing 25 cc. of solution, with 20 cc. of half normal solution of soda, in the presence of rosolic acid. The flask is heated in a water bath until it boils for two hours, after which it is cooled. 25 cc. of this solution are now titrated, with half normal potash in the presence of a few drops of alcoholic solution of 3 percent rosolic acid, the number of cubic centimeters of potash used being noted.

Exactly 5 cc. of essence are weighed and turned into a 250 cc. mattrass, adding a few drops of rosolic acid, neutralizing the acidity with half normal potash, only a very few drops being needed. 25 cc. of the preceding solution are then added, and the uncovered mattrass is carried to the double boiler, plugging it with a cork stopper after it is

already very hot. It continues to be heated moderately for forty-five minutes, being agitated constantly. It is allowed to cool and the excess acidity is titrated with the half normal solution of potash.

From the difference in the number of cubic centimeters of half normal potash necessary to effect the titration in the two cases, which reflects the decrease in the acidity, the percentage of citral of the essence is calculated, according to the formula:

$$\frac{d \times 2.533}{p}$$

where p is the weight of the essence, and d the difference found.

In addition to those described, there are many other methods for the analysis of citral and the total aldehydes, such as that of Walter, modified by Bennet, that of Berte, that of Stakler, and that of Hittner. However, we believe that we have given sufficient data to make it possible to analyze this essence with accuracy.